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NOTICE TO READERS

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ELECTRICAL WORLD AND ENGINEER.

SPECIAL ANNOUNCEMENT TO ADVERTISERS.

The attention of advertisers is directed to an important announcement appearing on page xvi of the advertising section of this issue, on the subject of the new schedule of advertising rates taking effect January 1, 1903.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of the ELECTRICAL WORLD AND ENGINEER by 10 A. M. MONDAY of the week of issue. New advertisements can be received up to noon of Tuesday of the week of issue.

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OUTLOOK AND INLOOK.

Aside from flurries in Wall Street, due to excessive stock speculation and manipulation, the conditions of the country at the present moment are every way encouraging, and could hardly be better. Capital is well employed; labor is in demand, and yet so far from over production are the markets that manufactured goods show a tendency to rise in price the moment output is slackened. It would appear that some time must yet elapse before the country has reached in facilities the full measure of its needs, and where producers must call a halt, for lack of demand. Indeed, if it were not for the large supplies brought in from beyond seas, some lines of industry would be suffering, and thus American trade activity has done much to brighten the situation in Europe, beclouded by German depression and by the strain endured in England through the long struggle in Africa.

While the home outlook, therefore, is encouraging, there would be more satisfaction in it if the beginnings made of export trade in many branches were not nipp d in the bud by a prosperity which tempts the manufacturer to neglect foreign markets. That this check has been felt is not to be denied, and it implies, unfortunately, a certain amount of wasted time and effort, with the consequent difficulties of renewing broken connections and affiliations. Complaints have reached us from parties abroad with whom a start had been made, but who find now that they must wait months for apparatus, or that it is not particularly cared whether their orders are filled or not. On the contrary, we are glad to know that some manufacturers are nursing and pushing their foreign trade steadily and persistently, knowing how intrinsically valuable it is in increasing the volume of production, and in providing new outlets.

Under all the circumstances, it is at least encouraging to find that the export trade in August was excellent. It is shown by the figures of the Treasury Bureau of Statistics that exports of manufactures have increased $2,000,000 and more, for August, over the same month last year, and are not less than $12,000,000 better for the eight months. We are inclined to consider this a good showing, for it really would not have been surprising if there had been no export manufactures at all. Factories are, moreover, still increasing their imports of raw materials, which have come to constitute a striking proportion of the import movement.

THE DETROIT CONVENTION.

Anyone who has had the experience of the editors of this journal in attending conventions this year—or most years for that matter—might be forgiven for thinking they were a bit overdone. In fact, we have heard in many quarters, from manufacturers, engineers, dealers and others, a complaint that conventions were becoming so numerous as to be a burdensome tax on time and a growing expense that showed little increase in return. There may be some truth in all this, and we note even now a tendency for different bodies of similar or allied interests to get together at the same time and place with economy in many directions as the result. Thus the centrifugal and centripetal forces balance again, and busy people are rejoiced when they thus find that they can kill several birds at the one convention, instead of spreading themselves and their ammunition thinly over several in succession in all parts of the country. The convention habit is, indeed, an overmastering one, and has made a deep mark

in American social and industrial life. There are lots of folk who go to the conventions merely for the badges, the souvenirs, the entertainments and the "good time," but in the main conventions are attended because certain lines of policy are to be defended or attacked, because certain common interests need discussion, because interchange of experience is necessary, because professional and business ties must be maintained, because a representative body can command more influence and respect than does a man who puts himself forward to advocate his own pet views and projects or air some special grievance that does not hurt any public interest.

The meeting of the American Street Railway Association at Detroit next week is one of the conventions that could not be spared. While others might go off our list without much harm to anybody, if such a convention as this had not been instituted it would be forthwith called into existence. We are glad to know that in every respect the meeting promises to be up to the standard of recent years. The papers and discussions have risen in value, and concurrently the allied meetings of the street railway accountants have done much to determine and universalize the best practice in their branch of the industry. In other words, the annual meeting of the Association marks each year a stage of progress and improvement, and we trust it will be a long time before any other criticism can be passed.

THE LONG ARM OF THE TROLLEY.

The electric railway development that has taken place around Detroit, where the street railway convention meets next week, is far more striking than that which has taken place within the city. It is not to be forgotten, to the honor and credit of Detroit, that the fame and memory of Charles J. Van Depoele are connected with pioneer electric railway work within her limits, and that other experimental work was done there, going back to the earliest stages of the present development. In fact, it might be said that few, if any, cities could claim priority over Detroit in favoring and fostering the new motive power and in providing an opportunity for the trolley to prove what it could do in giving the public cheap, swift and improved transportation within city limits. If in some respects Detroit may not have kept abreast of the times, though we opine she is well up in all save conduit trolleys, her early patronage of electric railways gives her a good claim to the gratitude of all who now benefit by such methods of traction. It is a little curious, as to conduit trolleys, that in Detroit they had one of their earliest and most hopeful exemplifications. We have personally a very clear and pleasant recollection of riding over a conduit trolley road in Detroit about 1886, at a time when in the same vicinity Mr. Van Depoele was still working at the aerial over-running trolley that preceded the under-running trolley wheel contact.

But, to resume, as our pages this week show, it is around Detroit and all over the fair State of Michigan that the most notable trolley development has taken place. The boon that the trolley can be, and already is to rural communities on the outer side of the suburbs, is very strikingly exemplified in the work to which Detroit serves as a center. Many visitors to Detroit will find special interest and profit in studying this important development and aspect of the art on the spot; and their time thus occupied will be well spent.

PRESIDENT SCOTT'S ADDRESS.

We commend to all of our readers the admirable presidential address delivered by Mr. C. F. Scott at the recent meeting of the American Institute of Electrical Engineers, which is reprinted in full elsewhere. For as including a concise but comprehensive statement of the achievements and present status of the electrical industry and profession, it will be of interest to everyone laboring in the electrical field; and as pointing out how the usefulness of the Institute may be extended, it carries a message not only to all of the present members of that body, but also to the many who are eligible to membership and whose adhesion would so materially aid in furthering the aims of the Institute and in spreading its activity over a greater area. The engineer will, we believe, read with especial pleasure the address, for in it he will find expressed a lofty sense of the real dignity and usefulness of his profession. In this day when—momentarily only, we hope—commercialism is rampant and the doctrine of *force prime le droit* does not lack open exponents, it is refreshing to realize that the technical professions not only cling to the highest ideals but, in comparison at least, have outdistanced in many respects the so-called learned professions. Mr. Scott does not enter into the reasons for this, but undoubtedly one cause is the engineer's constant touch with Nature and her laws as systematized in science. In the words of Prof. John Perry, but recently president of the sister British society, "To utilize the forces of Nature, to combat Nature, to comprehend Nature as a child comprehends its mother, this is the pleasure and the pain of the engineer." The laws of nature admit of no quibbling but call for absolute rectitude of thought, and inculcate that truth alone will stand. Such mental environment can not have other than a wholesome effect on character—on right thinking in all matters.

President Scott touched upon the subject of engineering education, which, it will be recalled, formed the topic of Mr. Steinmetz's presidential address in June at Pittsfield. The views of these two leaders in their profession are so similar and so completely in harmony with the thought of many educators not in direct touch with practical engineering, that they merit special attention. Mr. Steinmetz maintained that it is not the function of the schools to turn out full-fledged engineers ostensibly equipped to handle engineering problems of any magnitude; for to do this successfully a very great deal of practical experience is required which cannot be imparted by the schools. All the educational institutions can do and should do, is to fit the student to take up practical engineering work as efficiently as possible. Their true rôle is to give the student a thorough understanding of the fundamental principles of electrical engineering and allied science, and a good knowledge of the methods of dealing with engineering problems. He pronounced memorizing an entirely useless waste of energy, since when needed formulas can be derived from the fundamental principles or looked up in the literature. President Scott considers the best education is that in which theoretical training in fundamental principles predominates; that the true function of practical work in a broad engineering education is not to produce skilled workmen or full-fledged engineers, but it is to supplement theoretical work, making it definite and certain, so that the student may properly assimilate the instruction which he receives. That a student should not make his mind a storehouse of facts, but he should learn where facts and information can be obtained and how to use them; that logical thinking and clear expression and general culture are indispensable in a profession that comes in touch with so many departments of science and engineering, as well as industrial and commercial and social activity; and that he must be a broad man with a broad educational foundation who would aspire, with any well-founded hope, to the fullest usefulness and success.

The address contains a number of valuable suggestions as to specific ways in which the work of the Institute may be broadened and advanced, perhaps the most important of which relate to local meetings in various parts of the country, and at universities and

technical schools with electrical engineering departments. A step in this direction was taken by including in the new constitution a provision for State and District organizations, but thus far this has been without effect. This has probably resulted not from lack of approval of the measure, but because of want of leadership. In the case of organizations like the American Institute of Electrical Engineers, the concern of all is apt to be considered the concern of no one in particular, and unless one or several persons take the initiative, nothing is usually done. It is, therefore, gratifying to know that Mr. Scott would make the organization of local bodies a feature of his administration, and all who may help should consider it a duty to lend their aid in the good work. If in each locality one or two members were to put a shoulder to the wheel, success would be assured; for no expense to the local membership is involved, and the benefit to be derived is so obvious that once started, a movement should be sure of attaining its end. The suggestion to organize meetings at schools, though an innovation here, is fortified by the fact that such a practice has been long established in Great Britain, where, we believe, all of the more important professional bodies have a student class of membership. Aside from the benefit to the students, such a measure would be of great value to the Institute through the increase of membership that would result, since upon graduation few would feel like severing the bond established at school with the organization representing the profession in which they are to gain a livelihood.

New Westinghouse Railway System.

While Mr. Lamme's Institute paper, which is reprinted in full elsewhere in our columns, gives some interesting details of the alternating-current system to be used on the Washington-Baltimore line, it falls far short of being an adequate engineering presentation of the subject. It is particularly disappointing with respect to details as to the manner in which sparking is obviated at the commutator of the type of motor to be used—a matter of supreme interest in view of the fact that this has been an obstacle that heretofore has baffled all attempts to utilize in any line of work the series-wound commutator alternating-current motor, if we except small fan motors and fleeting use of its properties in starting. The system as a whole is, however, certainly a striking innovation in railway practice, worthy of serious consideration. We have again and again urged the necessity of getting to work on an alternating-current system of some sort, and we take great pleasure in the prospect of really thorough tests on a large scale, such as will soon be made with the Arnold and this latest system. As to the particular methods to be used in this instance, they must stand or fall on their own merits. We do not feel, however, that Mr. Lamme has fully expressed the relation of alternating to direct-current methods in railway working. The modern railway motor is, truly enough, a series-wound machine, but it is far from possessing the typical field characteristics of a series-wound constant-potential system. As railway motors are actually constructed, the fields are pretty well saturated at all working loads to secure efficient use of the material, and as a matter of fact their strong point is not the connection of the fields but the beautifully effective way in which they have been adapted to series-parallel control, which is the keystone of modern interurban practice. So far as speed control is concerned, it can be obtained by rheostats in the secondaries of polyphase motors quite as well as in pure rheostatic control of direct-current railway motors, but the former do not yet lend themselves readily to the series-parallel arrangement, and hence are at a disadvantage. Obviously, a single running contact is highly desirable with any type of motor, and this the new Westinghouse scheme has to its credit, although in its first application it has to face the annoyance of installing a double trolley and using it over part of the proposed route.

The series-wound, low-frequency, alternating-current motor is a rather old acquaintance, although it has never before been worked out on apparently so business-like a scale. The late Rudolf Eickemeyer built several interesting machines of this type, and a little later they were proposed by Prof. Forbes in connection with the Niagara plant. The trouble heretofore met in the premises has been, as stated before, irremediable sparking, which Mr. Lamme says has been averted in the present instance. If this contention is substantiated the result reflects infinite credit on the designer, and will open up an entirely new field in alternating-current practice. The hysteretic losses in such motors are obviously serious even at low frequency if the iron is worked at anywhere nearly as high saturation as is the rule in direct-current motors, and while no figures on the weights of the new motors are given, we shall be surprised if they are not greatly in excess of current practice. Their characteristics under brake tests, given in the paper, are excellent, and particularly the high average power factor and efficiency. It is to be regretted that the efficiency at low speeds obtained by the inductive regulator, and including the apparatus, were not added, since in railway working this is a very important matter. Ordinary direct-current equipments have in virtue of the series-parallel arrangement a very economical low-speed point, and if the alternating-current device can show a similar advantage it has certainly scored an important point. We would much like to see a comparative set of efficiency tests at car speeds of, say, ten to twenty-five miles per hour, and during acceleration, obtained from the new alternating equipment and from a standard four-motor car equipment of the ordinary kind. But, after all, the main thing is the high voltage of distribution possible when using alternating-current methods, and one could well afford some loss and inconvenience in the motors to secure so valuable an end.

The new plan has a material advantage over the polyphase railway systems developed abroad in the use of a single running contact, albeit the initial road cannot reap the full benefit in the case. Whether this advantage compensates for the need of a commutating motor is a question that experience only can answer. In this country there is a deep-rooted objection to double trolley systems that no ordinary considerations can overcome and certainly, other things being equal, a single-phase system will have a great advantage. But to obtain a firm hold on railway practice, an alternating system of any character must show operative qualities of a higher order than have yet been in evidence here or abroad. There are now a number of polyphase roads scoring at least limited successes, and besides the Arnold system soon to be tried, there is in an experimental stage the system proposed by Emil Huber, based upon the Ward Leonard system of motor control, which, despite obvious complication, promises a delicacy and efficiency in speed control far greater than has yet been practically shown by any system employing alternating motors. The new Westinghouse apparatus must run the gauntlet of all these as well as get the better of the direct-current system with converter substations, before it can take a prominent place in the art, and the task is not a light one. But a simple alternating-current railway system has so many points in its favor that daring experiments are amply justified, and we trust that the new system will fully realize the hopes of its organizers. It is relatively simple, easy of installation, and aside from the motors themselves, is composed of well-tried elements. While the motors are of a type that has not hitherto been successful, and which has been assiduously shunned by constructors, the art of design has advanced, and the very low frequency chosen is favorable to commutation, so that it would be rash to predict difficulties. Certainly the project is in most competent hands and merits the closest attention on the part of engineers. We shall watch it with the greatest interest, and hope for early and successful results.

Large Gift to A. I. E. E. Library.

At the recent meeting of the American Institute of Electrical Engineers, President Scott announced that the Library Committee had received from Mr. C. O. Mailloux a check for $1,028.23, representing the cost of purchase and binding of a number of valuable sets of transactions of French scientific societies, and other books. The announcement was also made that Mr. Mailloux will donate to the library a sum of money, the annual proceeds of which will be sufficient to pay the future cost of subscription to such of the periodical publications he has presented to the Library that are yet current, and also defray the cost of binding the same. The above donation, it may be added, is in addition to a full set of *Comptes Rendus* from 1835 to 1897 (130 volumes), which Mr. Mailloux presented to the Library about eighteen months ago, the cost of which, including new half-morocco binding, was $317. Following is a list of Mr. Mailloux's latest donation: Histoire et Memoires de l'Academie Royale des Sciences. 1666-1778; 171 vols. Memoires de l'Academie des Sciences. New Series. 1816-1900; 45 volumes and General Index. Memoires Presentes par Divers Savants a l'Academie des Sciences. New Series. 31 volumes. 1827-1894. Abridgement of Histoire et Memoires de l'Academie Royale des Sciences. 1666-1718; 1 volume. The Philosophical History and Memoires of the Royal Academy of Sciences at Paris. English Abridgement. 1699-1720; 5 vols. Historie de l'Academie des Sciences. By Maindron. 1888; 1 vol. Collection Academique. Memoires read before leading European scientific societies. 1755-1770; 9 vols. Recueil de Memoires. Memoires read before leading European scientific societies. 1754-1770; 4 vols. Annales de Chimie et Physique. 1789-1900; 303 vols. and 9 vols. indexes. Journal de Physique. 1872-1900; 29 vols. Zeitschrift des Oesterr. Ingenieurs und Architeken Verein. 1855-1901. Both weekly and monthly editions. Zeitschrift fur Instrumentenkunde. 1881-1901; 21 vols. It is understood that Mr. Mailloux has authorized the Library Committee to complete at his cost the set of French Memoirs, which requires only the volumes from 1778 to 1816, to make it complete from 1666 to date.

Electric Cars for New York Underground.

As the time approaches for the equipment of the underground road in New York City, details of the cars become interesting. The following data compares them with the cars on the Manhattan Elevated:

Length over platforms—Interborough, 50 feet 1 inch; Manhattan, 47 feet 1 inch.

Length over car body—Interborough, 42 feet 7 inches; Manhattan, 39 feet 10 inches.

Wheel-base of motor truck—Interborough, 6 feet 8 inches; Manhattan, 6 feet.

Width over window stools—Interborough, 8 feet 11⅝ inches; Manhattan, 8 feet 9 inches.

Width over sheathing—Interborough, 8 feet 9¾ inches; Manhattan, 8 feet 7 inches.

Width over deck eaves moulding—Interborough, 8 feet 5 inches; Manhattan, 8 feet 9½ inches.

Width over clere story—Interborough, 5 feet 9 inches; Manhattan; 5 feet 6½ inches.

Height top of rail, center draw-bar—Interborough, 2 feet 5 inches; Manhattan, 2 feet 5 inches.

Height top of rail over platform—Interborough, 3 feet 8 inches; Manhattan, 3 feet 9 inches.

Height top of rail over roof—Interborough, 12 feet; Manhattan, 12 feet 10½ inches.

The cars have been framed to be extra strong in all respects; the underframing is a composite one of steel shapes. The platforms are vestibuled with stationary end partition, provided with anti-telescoping steel bars set on edge and running from the under side of platform end sill to the car roof. These steel cars are framed into a continuous end plate underneath the platform in such a way that in order to have one platform ride over the other eight square inches of steel will have to be sheared off. The platforms are also arranged with the patented coupler and buffer, giving a continuous footway between the cars at all times.

The platform vestibules are provided on these sample cars with various types of doors and mechanism for operating the same, in order that the most serviceable arrangement may be decided upon after comparison of the various devices. In all cases the platforms will be closed, providing absolute safety for passengers on high-speed trains. It will be noted from the dimensions given above that the car is narrower at the eaves than at the floor line. This was done to give the greatest possible width of car for comfortable seating and at the same time to conform to the clearance of subway on curves.

Various arrangements and types of seats have been tried in these cars, with a view to making a selection of the most comfortable and serviceable seats. In general, the seating arrangement is very similar to that used on the Manhattan Elevated road, this arrangement having been found by experience to be best adapted for the class of service contemplated. The cars are arranged to seat 52 passengers, the Manhattan cars seating 48.

The trains will be made up of motor and trailer cars as the requirements of the service demand, the interior of the cars being the same for either. The motor cars will be equipped with two motors mounted on one truck at one end, whereas the trailer cars will have no motors. The cars will be equipped with automatic air brakes, electric lights, head lights, heating apparatus, and the ordinary equipment required for operation. Model cars have been submitted by manufacturers, and it is said that the Interborough Company will order 800 as a first equipment.

Advertising for Telegraph Business.

That even the old business of telegraphy may be stimulated and benefitted by advertising, as are telephony and electric lighting, has hardly been suspected by some of the gray-beards and conservatives, but we give below the experience of Mr. G. Herbert Wright, manager of the Postal Telegraph office in Danvers, Mass. When the Postal office was established in Danvers it was practically against the judgment of the company, but was instituted by request of the town officials, as reciprocation for certain municipal privileges. Mr. Wright says: "I first took charge of the local office of the Postal Telegraph-Cable Company as its manager on the afternoon of January 22, 1897. Up to this time the Western Union Company had enjoyed the monopoly of the telegraph business and had fought hard to keep the new competitor out, but without success, and I was placed in charge of the new enterprise. It was something of an experiment on the part of the Postal Company, and I realized that much depended on my personal attention to and hustling for business, if the experiment was to be a success in a town the size of Danvers.

"Our office was opened at first in the Danvers *Mirror* printing office, on the second floor of the Ropes Block. I had a good chance to study advertising in all its phases, and decided to try it as a means of getting business. I placed an advertisement in the *Mirror*, changing its subject from time to time. I also ran catchy ads now and then in the daily paper. I was very careful to avoid any reference to my competitor, simply booming my own company. Only a few months passed before things began to get interesting. The Western Union were losing business to a great extent, and it was coming my way. I was centrally located, and hammered away on that fact. They were not. In the summer of 1898 they moved their office to a drug store a few doors below me on the same side of the street, on a ground floor. About this time I had a wire placed in my residence, enabling me to handle business at all hours of the night, and I advertised this extensively. During the summer of 1899 it became evident that our quarters were inadequate, and I secured much larger space in the Colcord-Richardson Company's store on a ground floor.

"It was at this time that I began more extensive and systematic advertising. I also took the agency for a number of steamship lines, and in advertising them always made it a point to work in the Postal Telegraph office. Starting at practically nothing five years ago, I have, in the face of persistent opposition, built up a good business for the office, and placed it on a paying basis."

Naval Wireless Telegraphy.

Letters and words were successfully transmitted on September 23 from the Naval Academy at Annapolis to Washington, D. C., by means of the Slaby-Arco system.

Detroit Electric Railways.

AS one of the first cities to earnestly take up the electric railway, and one of the very earliest to enter the interurban field, Detroit, Mich., was a fitting selection for a meeting place of the American Street Railway Convention. In view of the increasing interest in interurban railways it would indeed be a problem to find a locality where the current developments in this branch can be better observed than in the vicinity of the City of the Straits.

The railway systems centering in Detroit are, with the exception of the Ypsilanti, Ann Arbor & Jackson road—a purely interurban line—controlled by the Detroit United Railway Company. In addition to the city lines there are five interurban systems, as follows: Detroit & Pontiac Railway (Pontiac Division), 36.52 miles; Detroit, Rochester, Romeo & Lake Orion Railway (Flint Division), 85.31 miles; Detroit & Northwestern Railway (Orchard Lake Division), 58.77 miles; Wyandotte & Detroit River Railway (Wyandotte Division), 10.78 miles, and Detroit & Port Huron Shore Line Railway, 109.57 miles. The last mentioned is operated independently and known popularly as the Rapid Railway System. The total interurban mileage is thus 301.15, which added to 187 miles of city lines gives the United Company a total mileage of 488.15.

The independent interurban company above mentioned operates 100 miles, thus making the total length of interurban line terminating in Detroit 401.5 miles. The interurban roads serve about 60 towns and cities, the most distant being Jackson on the Ypsilanti road, 76 miles, the fare being $1.05 and the running time 3 hours and 45 minutes; Port Huron, on the Rapid Railway, 73 miles, the running time 3 hours and 25 minutes, and the cost 90 cents for the trip; and Flint on the Flint Division of the United Railway, the distance being 68 miles, the fare $1, and the running time 3 hours and 15 minutes. The population of the towns and villages served by the interurban system is about 130,000; if to this is added the rural population of 20,000 the population per mile is 374.

The service, with some few exceptions, is hourly. While the city speeds average about 20 miles per hour, a maximum speed as high as 40 to 45 miles per hour is made, and in exceptional cases as high as 50 miles. The present equipments comprise 4 motors of 60 to 75 horse-power per car, the car seating from 50 to 60 people. The capitalization of the interurban lines averages about $40,000 per mile of track, about equally divided between stock and bonds. The annual earnings per mile of track average about $3,500. An interesting development in the Detroit interurban service has been a preference for the purchase of right-of-way instead of relying upon franchises, which experience has shown are apt at one time or another to give rise to embarrassment.

The operation of such long lines of interurban railroad naturally brought forward many problems for solution. The situation is quite different with respect to steam railroads, owing to the many turn-outs, short curves and the constant stopping for passengers. On the Rapid Railway System much care is giving to the training of the operating personnel, an apprenticeship of four to six weeks being required for a motorman. This system employs about 80 motormen and conductors for regular service, with from 10 to 20 extra men. On this system the average ride per passenger is 12 miles.

We give below a general description of the generating and distributing plants of the Detroit United Railway System, of the Rapid Railway System and of the independent line, the Ypsilanti, Ann Arbor & Jackson Railway. Elsewhere appears a description in detail by Mr. S. T. Dodd, of the Flint Division of the United Railway.

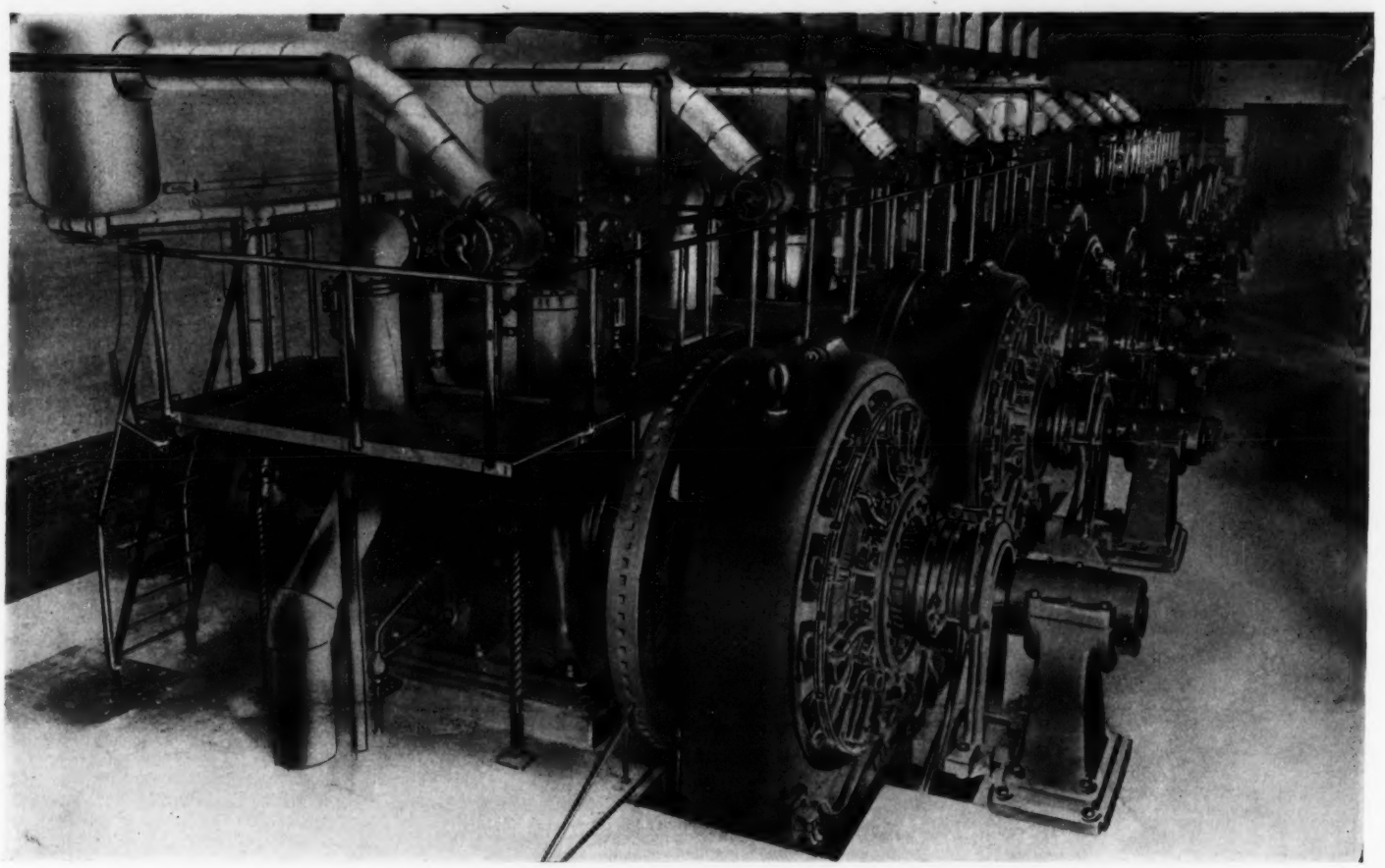


FIG. 1.—POWER PLANT DETROIT, YPSILANTI, ANN ARBOR AND JACKSON SYSTEM.

Owing to the short interval of time that has elapsed since the United Railway took over the four suburban lines which it operates directly, no comprehensive plan has yet been applied with respect to the generation and distribution of power, the several plants taken over being utilized at present as far as possible. On the Orchard Lake division running to Farmington, Northville and Orchard Lake the power distribution is all by direct current with boosters from a power house at Farmington Junction. On the Pontiac division the distribution is all by direct current from a power house at Birmingham. On the Flint division, running from Royal Oak Junction to Rochester, Romeo, Lake Orion and Flint, there is a direct-current power house, at Rochester, which, with the aid of a booster, feeds south 14.6 miles towards Detroit as far as Royal Oak, and also to Romeo and toward Lake Orion. A description in detail of this power house and the distribution therefrom is given in Mr. Dodd's article, above referred to. The interurban line to Wyandotte is run from the city power houses with the aid of a booster and a 280-ampere hour storage battery at Ecorse.

The city power distribution of the Detroit United Railway Company is all by direct current from two power houses, located diagonally across the street from each other near Riopelle Street and the river front. One of these power houses was originally built by the Detroit Citizens' Street Railway Company, and is called Station A. The other was built by the Detroit Railway Company and is called Station B. Since the consolidation the operation of these two power houses has been combined in a rather unusual manner. The switchboard for both power houses is centralized in one power house, and the two power houses are operated electrically just as if they were one, although the engines and generators are under different roofs with a street intervening, and nothing but telephonic means of quick communication between them. The positive generator switchboard leads and shunt field leads in Station B are run across the street to the other power house, and there terminate on regular generator panels. No switches are located in the Station B, save the equalizing switches on the generators, and these are on the negative side. The negative leads have no switches, but are connected permanently to the negative and ground. All other switches are in Station A.

The average length of the leads from the Station B generators to their switchboard panels in the other power house is about 600 feet. The generator leads between the two power houses are carried on poles just as if they were feeders. Only the positive leads are brought to the switchboard in any case, and consequently all switching is on the positive side. The equalizing switches being on the machines the only main switch needed on a generator panel is a positive switch and circuit breaker. This arrangement has worked to the entire satisfaction of all concerned. It makes it easy to shut down either one of the power houses at night, and practically makes one power house of them, as far as carrying the load is concerned. The number and capacity of the generators in operation can be adjusted to the load so as to give the generators a more economical load with this arrangement than if they were supplying different sets of feeders.

Another feature of interest about the switchboard is the use of three sets of bus-bars, which makes it possible to run feeders on any one of three different voltages. Two sets of bus-bars are run the entire length of the feeder board, and a third bus-bar runs part of the length. Part of the feeders can be connected to either the high or low bus-bars, and part can be thrown on the low or medium bus-bars. Each feeder has a double throw single-pole switch for connecting to either set of bus-bars. There is a paralleling switch between the medium and high voltage bus, so that these can be thrown together. The voltage of the highest bus is about 625, that of the medium 575 and that of the lowest 550 when operated independently. Generators 1, 2, 3 and 4, which are located in Station A (the one in which the switchboard is located) are arranged to connect with the low-voltage bus-bar as shown. Generators 5, 6, 7 and 8 in Station B, across the street, have their main switches arranged to connect the medium or 575-volt bus. Generator 9 in Station B has on its switchboard panel two single-pole single-throw main switches, by which it can be connected to either the medium bus in parallel with 5, 6, 7 and 8, or, on the high-voltage bus-bars, by itself as a 625-volt machine.

When the two switches on the panel of No. 9 are closed the effect is that of throwing the medium and high-voltage bus-bars in parallel, just as if the paralleling switch between the two were closed, and, in fact, both the paralleling switch and the two generator switches are usually closed when these busses are to be run in parallel. The 625-volt bus is run separately when the load is heavy on outlying trolley sections. When there is not such a load, and for purposes of economical loading of machines, it is desirable to run the high and medium voltage bus-bars in parallel, they are so connected. Out of 32 feeders leaving this board, 22 are arranged for connection to the high and medium bus-bars, and 10 can be connected to the low or medium bus. One matter which influenced the arrangement of the switchboard as it exists at present was the fact that the generators 1 to 8 cannot be raised as high as 625 volts. With the present arrangement they can be run on the shorter feeders, while generator 9, in power house B. supplies the feeders requiring the higher voltages when necessary.

In connection with this company's direct current distribution in the city of Detroit, two sets of storage batteries are employed, and on the Wyandotte and Trenton interurban line, which is fed by direct current and boosters from these city power houses, there is also a storage battery. One of these city batteries is located at Station A and the other in the northern central part of the city.

The Rapid Railway System was among the first of the interurban electric roads of the country to adopt an extensive system of alternating-current distribution. The power house which generates all the electrical energy used by the Rapid Railway system is located at New Baltimore, on Lake St. Clair, close to the line of the road, and supplies about 110 miles of city and interurban line. There are three units of 500 kilowatts each, the generators being three-phase, 390-volt machines, and the engines Westinghouse tandem compound condensing 21½-inch and 37-inch by 22-inch stroke. The two exciters are 35-kw, 125-volt direct-current generators, direct connected to Westinghouse compound engines. In the boiler plant four Babcock & Wilcox water-tube boilers are equipped with Roney mechanical stokers. A centrifugal pump raises the water about 21 feet for use in the Worthington jet condensers, which are located just under the boiler-room roof. Induced draft is used, there being two steam-driven draft fans, either one of which is sufficient to maintain draft for the plant. Before passing to the draft fans and the low stack, the flue gases are put through Green economizers, which reduce the temperature of the stack gases from about 520 degs. to 440 degs. A continuous record of flue-gas temperature is kept on the power-station log.

The three alternating-current generators are connected to a common set of three-phase bus-bars through single-throw, three-pole switches. From the 390-volt, three-phase bus-bars two rotary converters of 200-kw capacity each are operated directly, and supply the trolley lines near the power house. There are two sets of step-up transformers also operated from the alternating-current bus-bars. One set supplies the 16,000-volt high-tension transmission lines running north and the other set the high-tension line running south. There are, therefore, six transformers in regular service, with a seventh as reserve. Each bank of three transformers has a low-tension panel, though which the current to it passes. The frequency of the alternating current in this station is 28 cycles, which is rather unusual. The high-tension lines extend 40 miles north to Port Huron, and 21 miles south toward Detroit, as far as Roseville sub-station. In addition to the current supplied to the trolley line from the rotary converters at New Baltimore power station, there are sub-stations at Mt. Clemens, at Roseville, at Algonac, at St. Clair, and at Port Huron. The latter supplies city lines in Port Huron. The majority of the sub-stations are equipped with 200-kw rotary converters.

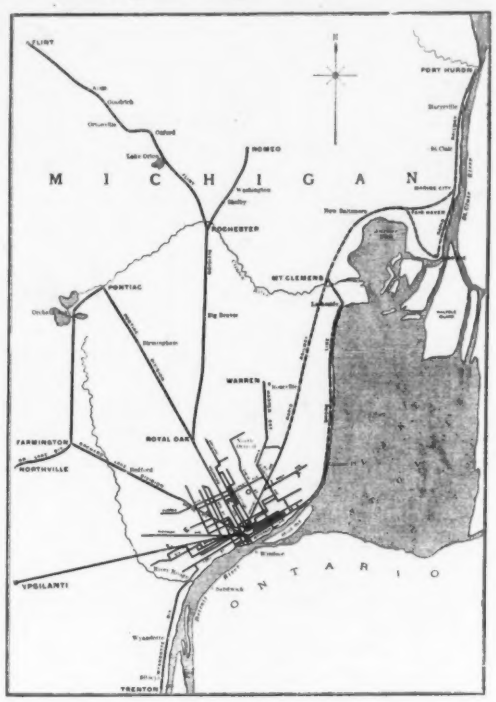


FIG. 2.—MAP OF STREET RAILWAY SYSTEM OF DETROIT AND ENVIRONS.

The arrangement for feeding direct current from the sub-stations to the trolley lines is of interest. The trolley line is sectioned opposite each sub-station, as is customary in alternating-current transmission practice for interurban lines, and, as usual, there are two feeders leaving the direct-current bus-bars at the sub-station,

one for supplying the trolley line in one direction and the other for supplying the trolley line in the other direction. Each trolley section, therefore, is fed by the sub-station at each end, so that the sub-stations can, to a certain extent, help each other in carrying the load, and as long as all the feeder-panel switches and circuit breakers are closed all the trolley-wire sections on the road are connected together. In case of short circuit on one section the feeder-panel circuit breakers in the sub-station at each end will open.

The peculiar thing about the direct-current feed on the Rapid Railway System is that instead of connecting the feeders directly to the trolley line at the sub-station no tap is made to the trolley line until about a mile from the sub-station, the argument being this does not throw so great a strain on the sub-station machinery in case there is a ground or short circuit near the sub-station. The current that will flow in case of a short circuit is reduced somewhat by the resistance of the feed wire between the sub-station and the first trolley tap, and, even though this resistance may be small, it serves in a measure to reduce the current which may flow. After a direct-current feeder has been tapped into the trolley line about a mile from the sub-station, taps are made to the trolley line after that every twelve to fifteen poles.

On the lines between Mt. Clemens and Port Huron the direct-current copper consists of two No. 00 trolley wires supplemented by a 450,000 cm. feeder. From Mt. Clemens to Detroit along the Shore Line there are two No. 00 trolleys supplemented at Mt. Clemens by a 450,000-cm. feeder from the Mt. Clemens sub-station, and at the Detroit end by a 450,000-cm. feeder run across country from the Roseville sub-station. On the Shore Line between Mt. Clemens and Detroit where interurban traffic is the heaviest, there are two No. 00 trolleys and three No. 000 running each direction.

Before the Port Huron and city lines were operated from the New Baltimore power house a good opportunity was afforded for determining the power required per car mile for interurban cars of the kind used on the Rapid Railway. Most of the cars on the Rapid Railway are geared for a maximum speed of about 45 miles per hour, some of them being four-motor equipments, and some two-motor. The four-motor equipments usually reach maximum speed sooner than the two-motor equipments, although when up to speed they run about the same. It was found that the power required per car-mile for the interurban cars as measured at the low-tension bus-bars at the power house, and which includes, therefore, the losses in step-up and step-down transformers, high-tension lines, rotary converters and direct-current feeders, was about 3 kw-hours. In a trial to determine the maximum load coming upon the power house when running interurban cars alone, there were in operation eight 29-ton passenger cars, four-motor equipment; six 21-ton passenger cars, two-motor equipment; three 25-ton freight cars, four-motor equipment; two line construction cars, and two 8-ton city cars in Mt. Clemens, or 21 cars in all.

The output for a run of twenty hours was about 14,000 kw-hours, or an average of 700 kw. This represents an average input of 33.3 kw per car in service. Of course, for the interurban passenger cars which are in motion a greater part of the time the input per car would be considerably more than this, as the above list includes the freight cars, line construction cars and two light city cars. In fact, the power required by the city cars is probably in the neighborhood of 15 kw average, or less than one-half that of an interurban car. With the above list of cars in operation, the maximum evening load, when nearly all the cars would be moving, was about 1,384 kw, a maximum of 65.9 kw per car.

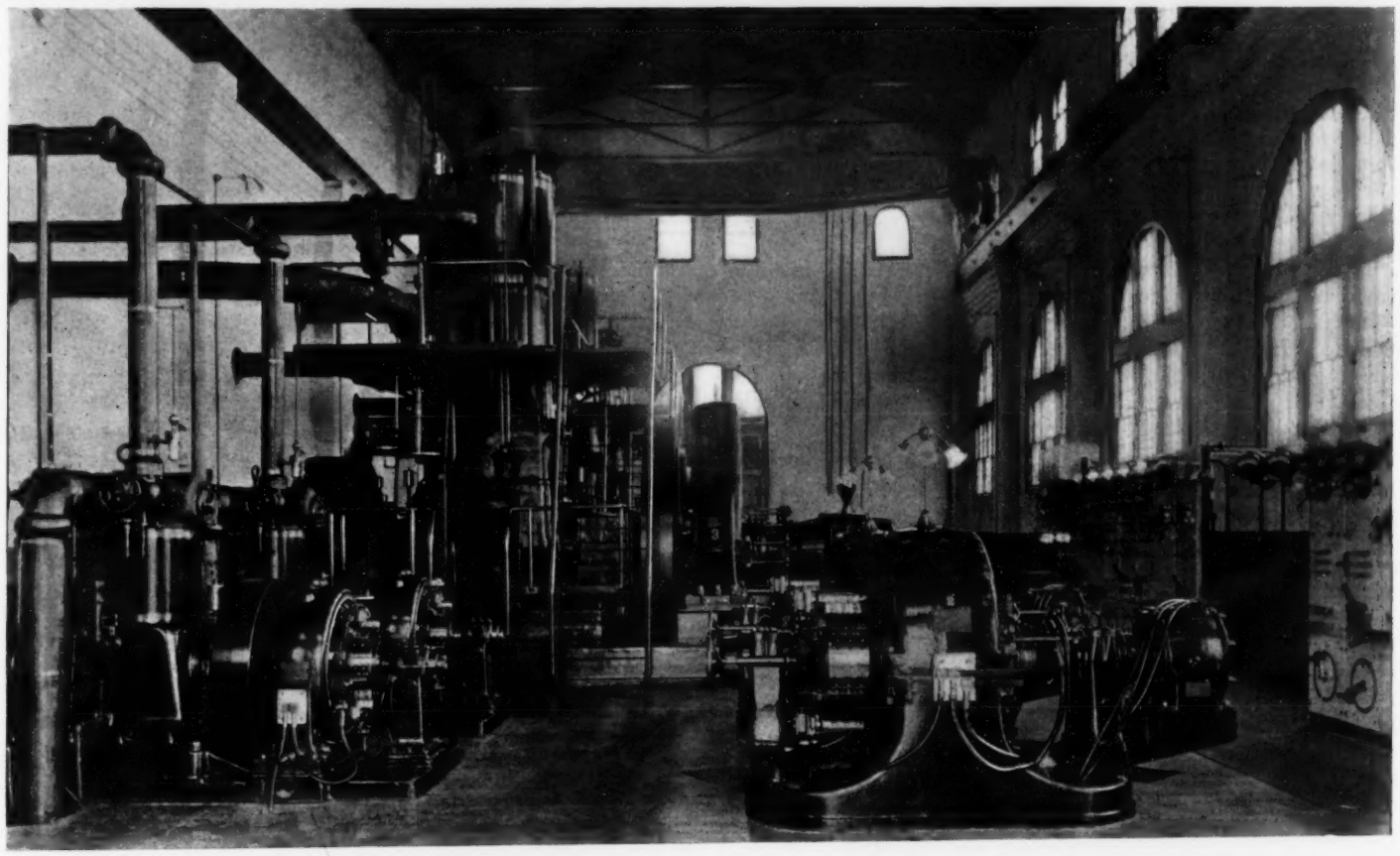


FIG. 3.—NEW BALTIMORE POWER HOUSE, DETROIT RAPID SYSTEM.

The Detroit, Ypsilanti, Ann Arbor and Jackson Railway operates the longest continuous line of interurban electric road out of Detroit, extending from the Detroit city limits to Jackson, a distance of 76 miles, with a branch to Saline. It was formerly operated by two power houses, but these have recently been combined into one combination alternating and direct-current power station at Ypsilanti, which is the most modern of any in the vicinity of Detroit.

In the boiler room are eight 225-hp Babcock & Wilcox boilers, carrying 160 lbs. steam pressure, and employing induced draft. The flue gases pass through Greene economizers, and the boiler firing is done by Roney mechanical stokers divided in two sections, four boilers on each section.

The main engines, of which there are eight, are all the same size, being Westinghouse high-speed compound condensing 18-inch and 30-inch by 16-inch stroke, running 200 r. p. m. Each engine has one Worthington compound jet condenser. To five of these engines 250-kw three-phase alternators are connected. These are 390-volt machines, operating at the usual frequency of 29 cycles per second. The remaining three engines have 250-kw double-current generators, giving 650 volts on the direct-current commutator, or 390 volts at the alternating-current collector rings. The two exciters are 50-kw,

125-volt machines, driven by Westinghouse compound engines, running condensing or non-condensing. These are also used to light the offices and shops.

All the alternating-current generators are operated in parallel, and there is no provision for other than parallel operation. On the switchboard, there are eight alternating-current generator panels, each of which has a three-pole knife switch for breaking the main generator circuit, a double-pole field switch, the rheostat in the generator field circuit, three alternating-current ammeters, one indicating wattmeter, synchronizing lamps and voltmeter and synchronizing plug receptacles. Generators connect through their three-pole main switches without any further circuit breaking devices, directly to the low-tension alternating-current bus-bars.

The entire alternating-current output is delivered to one bank of three delta-connected step-up transformers. The only automatic circuit breakers in connection with the low-tension switching in the station are in the three legs of the circuit supplying these transformers. Each leg of this main circuit has a switchboard panel, upon which is an alternating-current automatic circuit breaker with a time limit is placed. The time limit is put on these breakers, so that in case there is a short-circuit at one of the substations the circuit breakers at the substations will open before those at the main station, the idea being that frequently this will save shutting down the whole system by the opening of the circuit breakers in the main power house, where opening the substation breakers would do as well. In each leg of the circuit there are also single-pole knife switches of 3,000-amperes capacity. The total output is measured by a polyphase induction integrating wattmeter at one end of the low-tension switchboard just described, which contains the generator and transformer panels. There are two voltmeters on brackets at the end of the board. One of these is connected permanently to the bus-bars, the other to any generator which is being prepared for connection to the bus-bars. Along with the voltmeters there is also a Westinghouse synchroscope for use in getting generators in step with the bus-bars before connecting them in. This indicates directly the amount that the generator is out of step, and it is a much more accurate guide than synchronizing with lamps.

The step-up transformers raise the voltage from 390 volts to 21,000 volts. The high-tension leads from the transformers are taken to plug switches, which serve simply to transfer or open connections, and then to static interrupters, from which they pass to a long-break combination switch and fuse. The lightning arresters are connected between each leg of the high-tension line and ground. All the high-tension apparatus is in a bay or tower, built on one side of the generating room and providing not only a wire tower for the entrance of the high-tension lines, but containing galleries for the high-tension switches and lightning arresters. The high-tension apparatus is therefore isolated to a certain extent from the rest of the plant. This same idea is carried out in the substations, which have towers on a smaller scale for the high-tension apparatus.

The direct-current terminals of the double-current generators are connected to the ordinary direct-current generator panels and supply lines adjacent to the power house through three direct-current feeder panels. These generator panels have three single-pole main switches —for positive, negative and equalizer. The automatic circuit breaker is on the negative side. The feeder panels have the usual equipment of an ammeter, circuit breaker and single-pole switch. The direct-current output is also measured by recording wattmeter.

The substation buildings are of steel and brick with towers, as mentioned, and each is laid out to contain three 200-kw transformers and two 250-kw rotary converters, with room for one extra rotary converter. There are, of course, switchboard panels for the alternating-current side of the rotaries and direct-current side. There are two feeder panels at each substation, one feeding east and the other west.

The trolley lines are sectioned in front of each substation. The cars operated regularly are: 13 interurban passenger cars; 4 local city cars at Ann Arbor; 4 freight cars, and 1 construction car; a total of 22. On this load five of the 250-kw units are run. The new cars have a seating capacity of 60 people, and a motor equipment of four Westinghouse motors, taking from 150 amperes to 200 amperes, running at the maximum speed of about 45 miles per hour. The accelerating current is from 150 amperes to 200 amperes, with motors in series, and from 300 amperes to 350 amperes whey they are thrown in parallel, making ordinary starts. This acceleration current sometimes reaches 450 amperes, though not frequently.

The cars were formerly equipped with Westinghouse automatic air brakes, but these have been changed to Westinghouse straight air brakes, because of the greater ease and accuracy with which a motorman can regulate exactly the pressure on the brake-shoe with a straight air brake.

The regular schedule calls for cars every half hour east of Ypsilanti, and cars every hour west of Ypsilanti. When special traffic is handled from Jackson, the western terminus of the road, cars are run every half hour, the fact that these cars will be run being advertised in the local papers. It is found that this is sufficient to prevent overloading of the regular cars running on the one-hour intervals. Special cars can be chartered when ordered, and the charge is made on the mileage basis.

About 70 conductors and motormen are kept on the pay roll. All runs less than eight hours are termed "extra runs," and the men having them are given chances at the ordinary runs whenever the regular men are off. The road is not operated in divisions, but train crews make the entire run through from Jackson to Detroit and return. Twelve freight offices with regular agents are maintained.

Train Lifting by Electricity.

It is stated from Baltimore that a tremendous enterprise is contemplated by the Gould-Wabash system on the line of the West Virginia Central. Plans have been drawn by which it is expected to lift whole trains loaded with coal or merchandise up the side of a precipitous slope of the Great Backbone Mountains, in Tucker County, W. Va., by means of electric power, and by that method make a double track road with an easy down grade both ways. The plan, which is said to have been thoroughly worked out by the engineering corps of the railroad, is a most remarkable one in many ways. At present the line, going westward, after leaving Cumberland, runs through Keyser, Piedmont and Fairfax, and thus on into the Blackwater Canyon, where the scenery is wild and magnificent, but where it is impossible to maintain more than a single track. From Fairfax down on through this deep gorge the road descends a steep grade to Hendricks, and then makes a detour to Parsons, and from thence on up a slight grade to Elkins. Thus it can be seen that there is a big handicap at present, with a one-track road through the gorge and a tremendous grade coming east.

At first it was planned to make a considerable detour around the mountain range so as to get an even grade. To do this the line would have to follow the Cheet Run and extend from Fairfax to Hendricks, and this would involve a great loss of time. To overcome this it was decided to use the present gorge route for the westbound trains and build a unique eastbound track. It would be possible to have a double track road on a fair grade from Elkins to Parsons, and there the trains would run on a platform. It is then proposed to have this entire platform and its freight, a full train, move by electric power up a tremendous grade right to the highest elevation on the mountains. From that point an easy down grade can be found on the other side all the way to Fairfax. The operation of this great platform is, of course, a gigantic undertaking, but it is believed it can be successfully worked. The whole would be operated by electric power. To provide this power the large plant of the road at Cokeland would be drawn upon. The electric plant at that place at present supplies electric lighting and power for a large territory and furnishes electricity for the mines. There would be ample power, however, to move the platform and its freight up a sharp incline to a height of about 1,000 feet.

Wireless Telegraphy for Yachts.

It is noted from Larchmont, on Long Island Sound, that with a view of establishing wireless communication between the different yacht clubs along Long Island Sound stations were established at Larchmont and New Rochelle Yacht clubs last week, and the yachtsmen amused themselves by sending and receiving messages. Operators were stationed on the verandas of both clubhouses. Augustin Monroe, chairman of the house committee of the Larchmont Club, said that the test was a success. It is said that a number of wealthy yachtsmen intend to have their steam and big schooner yachts fitted out with the wireless telegraph outfits, so that they can communicate with their friends at the clubs at any time.

Flint Division of Detroit United Railway Company.

BY S. T. DODD.

IN the early days of electric railroads, when a five-mile road was considered long, a generator voltage of 550 was sufficient for operation at all points of the system. As the length of the roads gradually increased, they soon reached a length at which it was impossible, with the system then in use, to transmit power economically to the extreme points of the line with a reasonable investment in feeders.

To meet this condition, the booster was evolved and proved a practical success, from the operative standpoint, but not profitable, except where its function was required but a small percentage of the time, not exceeding two or three hours out of the twenty-four.

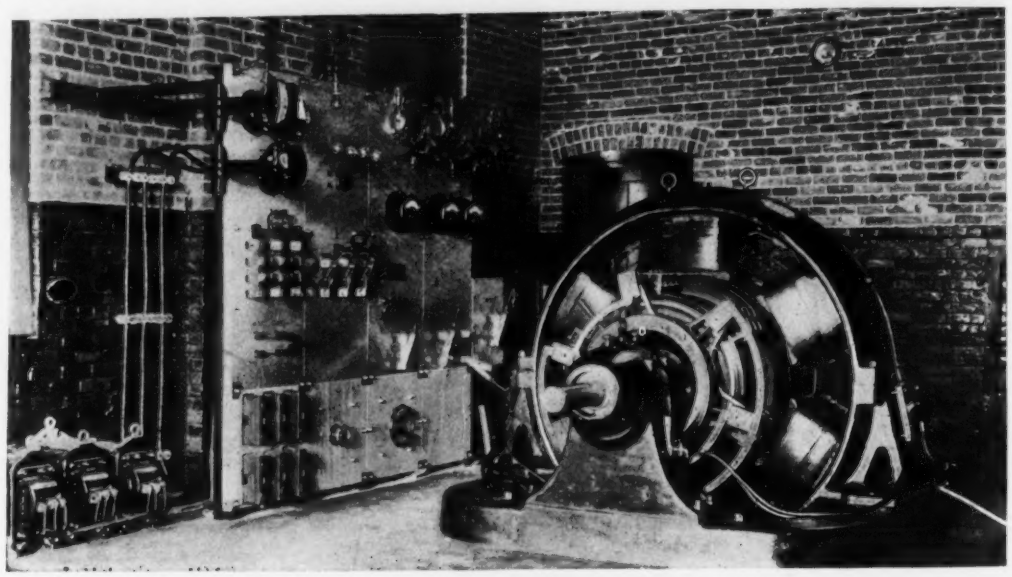


FIG. 1.—LOW-TENSION SWITCHBOARD, OXFORD SUBSTATION.

The storage battery has proved of value in equalizing the load on stations and in special cases. Where, for example, an excessive amount of current is required at a heavy grade located some distance from the power house, a storage battery located at such point is often the best means of meeting such conditions. But the storage battery has not served the purpose of maintaining the original voltage at distant points of the system.

The next step, when roads reached the length where they could not be operated from one direct-current power house, was to operate from two or more such stations, but the heavy operating expenses entailed through the necessary attendance for each of such stations, soon made it apparent that a means must be found to obviate the bulk of this expense, and further to take advantage of the economics resulting from the use of larger generating units and labor-saving power station equipments not found profitable with small stations.

The modern method of operating a long electric railroad, which experience both in this country and abroad has thus far shown to be the only practicable method, is to install one main power station with alternating-current generators, the alternating current being transmitted generally as a three-phase current at 10,000 to 25,000 volts, to substations located every ten to twenty miles, each substation being equipped with suitable step-down transformers and rotaries for transforming and converting the energy to direct current at a potential of from 550 to 600 volts.

A successful plant of rotaries in the neighborhood of Detroit is found on the Flint Division of the Detroit United Railway. This line extends northwesterly from Detroit to Flint, a distance of 66 miles. The alternating-current transmission was installed in 1901, and S. K. C. rotaries are in use, both in the power house and in the substations.

The cars of the Flint Division leave from in front of the City Hall every hour. The route lies directly northwest through the center of the city, and out Woodward Avenue to the city limits. Within the city limits the regular city cars of the Woodward Avenue line run on the same tracks, but beyond this point the large interurban cars of the Flint and Pontiac Divisions have the tracks to themselves. A great part of the road for the first six miles beyond the city is double-tracked, as cars of two divisions operate over it.

Royal Oak Junction, 12½ miles from the center of the city, is reached in 40 minutes. At this point the two divisions separate, the Pontiac line keeping on toward the west, while the cars for Flint turn more toward the north. Beyond Royal Oak the road is single track, running along the side of the highway with bracket construction overhead. A feature of the construction that strikes the observer is that the mileage is marked on the poles. Every fifth or sixth pole is marked with a broad white band, upon which, in black figures, is given the distance in miles and tenths from Royal Oak. There is no need of speculating long on the speed of the car. With an ordinary watch, the passenger can timethe miles as he goes along, and can quickly settle any question as to speed, and one always knows the distance he has traveled and the distance to his destination.

The power for the first 12 miles of theroad is furnished from the power houses at Detroit and Pontiac. The stretch of 14½ miles from Royal Oak to Rochester is fed with direct current from the Rochester power house, the section furthest from the power house being fed through a booster. s one notes the heavy feeder lines upon the transmission poles and contrasts this with the type of construction, he finds beyond Rochester, where the power is transmitted through a high-tension, alternating-current system, he realizes that this section of the road could have been equipped more economically if the alternating-current transmission plan had been adopted when the road was first built. The road runs through a level, fertile farming country, to which it affords both freight and passenger service. It is a beet sugar country, and in the fall the freight sidings along the road are occupied by freight cars loading with sugar beets for the factory at Rochester.

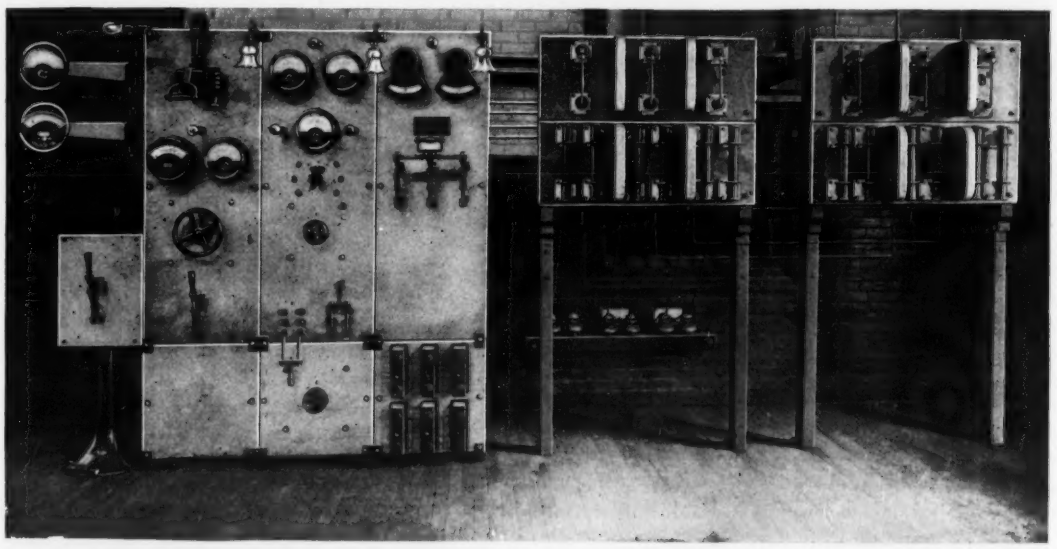


FIG. 2.—SWITCHBOARD IN ROCHESTER POWER HOUSE.

Rochester, 27½ miles from Detroit, is reached in one hour and 20 minutes, the distance from Royal Oak, 14½ miles, being covered in 40 minutes. Here is situated the power house and car barn of this

division. The power house shows evidence of that characteristic of so many of our suburban roads—the growth of the demands of traffic far beyond the original resources of the road. At one end stand two horizontal high-speed engines, direct connected to 200-kw, 600-volt, direct-current generators. With increased development of the road, a vertical engine direct connected to a 400-kw, direct-current generator has been added to the equipment. With the extension of the road to its present limit, the direct-current system has proved inadequate and an alternating-current transmission has been installed for

FIG. 3.—ROCHESTER POWER HOUSE.

the sections of the road beyond Rochester, with S. K. C. rotaries in the power houses and substations.

The rotary in the power house stands directly in front of the door as the visitor enters. It is rated at 250 kw and runs inverted, taking direct current from the 600-volt board and converting it into alternating current for the transmission line. The liberal design of the rotary arrests the attention. The commutator is 33 inches in diameter and has three carbon brushes per holder. The collector rings are 18 inches in diameter and are 2¼ inches broad, and carry two copper-leaf brushes per collector ring. These brushes are each 2 inches broad by ⅞ of an inch thick. There are three ½-inch ventilating ducts, through the body of the armature, and the splendid ventilation obtained keeps the armature at a low temperature in spite of the heavy overloads. The shaft is 7 inches in diameter at the armature and 5½ inches at the bearings. These bearings are each 22 inches long and are equipped with two oil rings dipping into ample oil cellars below the bearings. The flat, wide frame casting gives a steady and substantial appearance to the whole machine. The armature winding is thoroughly subdivided and a large number of slots used. This prevents local heating, conducive to good commutation, gives a wave of electromotive force free from harmonic, prevents eddy-current loss in pole faces and allows the use of desirable magnetic constants.

The machine is often heavily overloaded, as it has to furnish current for two substations, each of which is equipped with a 250-kw rotary. The violent fluctuations of the load are what might be expected on an interurban road running heavy cars on an hourly schedule. When the station was first equipped, an ammeter reading to 600 amperes—sufficient to indicate overload of 50 per cent.—was installed on the switchboard. The needle struck the end of the scale so often that an instrument reading to 1,000 amperes was substituted. From the readings of this instrument, it is evident that the rotary is frequently called upon to develop 500 to 500 kw, and it does so without flashing, overheating or other trouble.

To the right, as one stands in the doorway, is the old direct-current switchboard, from the bus-bars of which is delivered the current for the trolley circuits of the adjacent sections of the road and also the current for the rotary. In sharp contrast with this board, there stands on the left the modern switchboard, installed by the Stanley Electric Manufacturing Company for operating the inverted rotary and the high-tension transmission line. This switchboard is shown in Fig. 1.

The panel on the left is the direct-current panel. The current from the direct-current bus-bars for the rotary comes to this panel and passes in succession through the circuit breaker, ammeter, starting-box and switch. The only other instrument upon this panel is a 25-ampere ammeter, which indicates the field current of the rotary and gives the operator an opportunity to make a very close approximation as to its speed. Voltmeters for both alternating current and direct current are supported on swinging brackets from the side of this panel.

The next panel upon the board may be called the controlling panel. This has three ammeters at the top of the board, one in each of the three phases coming from the alternating-current end of the rotary. Two rheostats mounted upon the board control the voltage of the exciter, and the current passing from the exciter armature through the fields of the rotary. Two field switches are mounted upon the board, one of which excites the fields of the rotary from the 600-volt bus-bars when starting up, while the other connects the fields to the exciter after starting. A three-pole voltmeter switch upon the board enables the operator to read the voltage on the line and the voltage across the fields when charging from 600-volt excitation to the 120-volt excitation.

The next panel of the board is the alternating-current panel. This carries at the top two S. K. C. ground detectors. These ground detectors are connected to the low-tension side of the condensers which are carried upon the high-tension lines. A ground upon any one of these is indicated directly by one or both of the ground detectors. Below these instruments is a three-pole main switch connecting the leads from the rotaries to the transformers. Separate leads are run from each transformer to the board and the delta connection between them is made at the board. This arrangement makes it possible to place fuses in each one of the leads. These six fuses are placed at the bottom of the board. By this means of connection it is possible, in case of a defective transformer, to remove the two fuses from the same and thus cut this transformer out of circuit, leaving the other two transformers maintaining the three phases between the lines.

The board is lighted by nine incandescent lamps, six of which are connected to the rotary side of the switch, while the other three are connected to the transformer side of the switch. By this means, in case the main switch is opened, the operator can tell at a glance whether his transformers are being charged from the high-tension lines; that is, whether some other rotary is running upon the line or

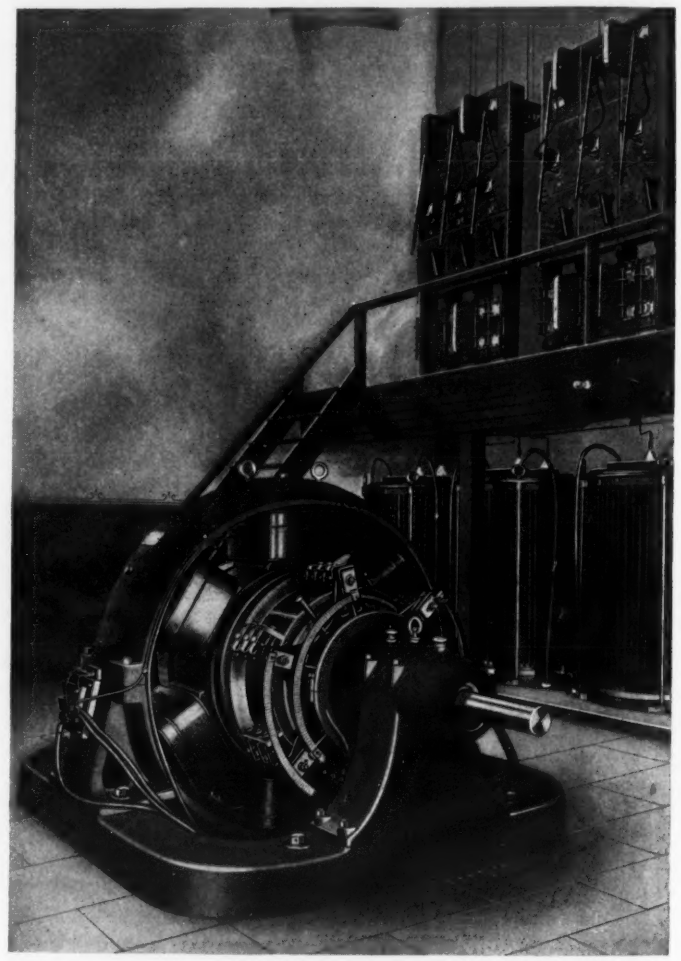


FIG. 4.—INTERIOR VIEW OF OXFORD SUBSTATION.

whether his line is dead. This prevents accidents which might occur if the inverted rotary was shut down for any reason and was thrown back upon the line while the other rotaries were still connected to it.

The transformers for this station are in a small separate building outside the power house. There are three of these of 250 kw each, of the oil-filled, self-cooled type, made by the Stanley Electric Manufacturing Company. Separate leads run from each transformer both

to the low-tension and high-tension boards shown in Fig. 2.

The high-tension panel stands beside the board already described, and carries upon the lower panels six high-tension ball fuses which are inserted in the separate leads running from the transformers. Above these fuses are mounted emergency switches for connecting the transformers to the high-tension lines. No instruments are mounted upon this board, as it is the practice of the builders to do all operating and controlling of the circuits from the instruments and switches upon the low-tension board. The alternating current is transmitted to the substations at a pressure of 15,000 volts.

The interval between cars has allowed ample time for an inspection of the power house. In order to inspect the substation, we board the next car running north to Oxford. Beyond Rochester there are deep cuts and heavy grades, and the road runs for most of the way over private right of way. It was originally constructed for 600-volt, direct-current transmission, with poles of the usual height. In installing the alternating-current transmission, the high-tension wires have been placed on cross-arms above the 600-volt feeders. Had the road been constructed for alternating-current transmission, the poles would have been longer, but it is an example of construction which is frequently adopted in the development of short suburban roads to greater distances than they were at first designed to cover. Above the high-tension wires is strung a barbed wire, grounded at frequent intervals, for protection against lightning.

The high-tension lines consist of six No. 4 aluminum cables. These constitute duplicate sets of three-phase transmission lines, which are ordinarily operated in parallel. In case of trouble, however, any line or a set may be cut out and the road operated over the remaining wires. Oxford, 27½ miles from Royal Oak, and 12 miles from the power house at Rochester, is reached in 40 minutes. The substation is located on the outskirts of the town.

The substation is a substantial brick building. At the front as we enter is the waiting room and express and ticket office. Next to this is a freight room, extending clear across the building, with doors opening on either side. From one of these a platform extends to the car track, where freight is unloaded from or delivered to the freight car, which makes trips night and morning over the road. At the other door wagons can drive up for receiving and delivering freight. Although the Michigan Central and Pontiac, Oxford and Northern Railroads have stations in Oxford, a considerable quantity of all classes of freight is daily handled by the electric line. Next to the freight room is the rotary station proper, which is open day and night. The work is divided between three shifts whose hours overlap so that during the busy hours of the day a dynamo tender and an express agent are on duty, while at night one man handles the station.

Examining the instruments in the rotary room, we find six high-tension lines enter the room on one side, pass directly across, supported on insulators from the rafters, and leave on the opposite side. The lines are provided with emergency switches in the middle of the room, which make it possible to cut out any line which is in trouble beyond Oxford, and operate all six lines as far as there.

Taps lead from each line to a high-tension switchboard which stands in the gallery. This board is equipped with air-break plug switches and compression ball fuses. As in the power house, leads are brought from the transformers directly to the board, and each transformer separately fused. The transformers being connected in delta between the fuses and the switches, the blowing of the fuses in one transformer leaves the load on the other two, the three-phase relation remaining undisturbed.

FIG. 6.—SUBSTATION AT OXFORD.

The transformers are of 100-kw capacity each, of the S. K. C. oil-filled, air-cooled type. They stand on the main floor below the gallery. From them the 360-volt current is carried by lead-covered cables to the low-tension switchboard, shown in Fig. 1. The trolley circuit is opened near the station, and one switch feeds north and the other south. In order to economize the load on the alternating-current line, the station ordinarily feeds north. When cars are behind schedule time south of the station, the other breaker and switch are closed, and the station helps out the line toward the power house. In starting up the plant after a shut down, the north breaker is left open so that only the cars between Oxford and Rochester can pull on the line and affect the voltage until the rotary is synchronized and on the line. As soon as this is done, the north switch is closed and the next station receives current and is allowed to start.

The rotary itself is similar in every respect to that in the power house, except that it is not equipped with a separate exciter, but is

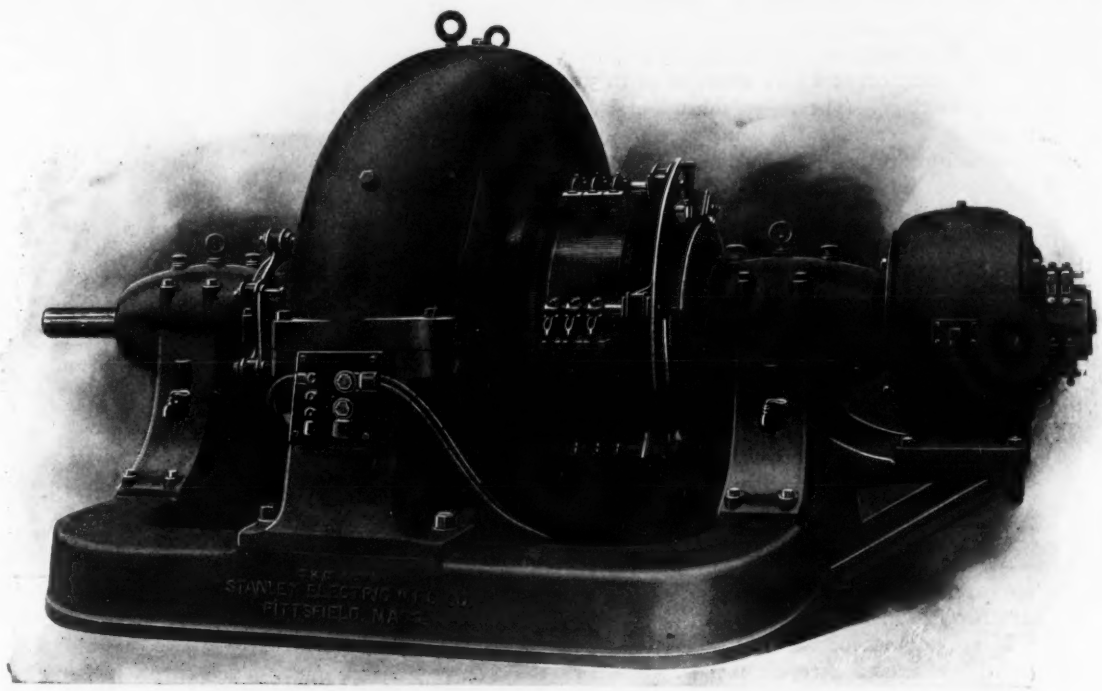


FIG. 5.—INVERTED ROTARY, ROCHESTER POWER HOUSE.

excited directly from its own direct-current voltage, 600 volts. The same characteristics of design and operation are to be noted on this machine as on the other. The method of connection of the transformers to the board, which has already been described, renders it possible to take one transformer out of the circuit without disturbing in any way the phase relations of the alternating-current lines or the operation of the rotary. In case of necessity, two transformers can be cut out and the rotary operated as a single-phase machine. The need for this seldom arises, but, as a matter of fact, during a heavy storm one evening last winter, four out of the six transmission lines came down early in the evening, and the road was operated until the usual closing time on two high-tension wires with one transformer to each rotary.

The next substation is at Atlas, 18 miles north of Oxford and 45½ miles from Royal Oak. The run from Oxford occupies an hour. Some of the best construction on the road is to be found on this section. The poles are all 35 to 40 feet in length, carrying the high-tension wires safely out of the way of the 500-volt circuits. The two sets of transmission lines are carried on opposite sides of the poles, one wire of

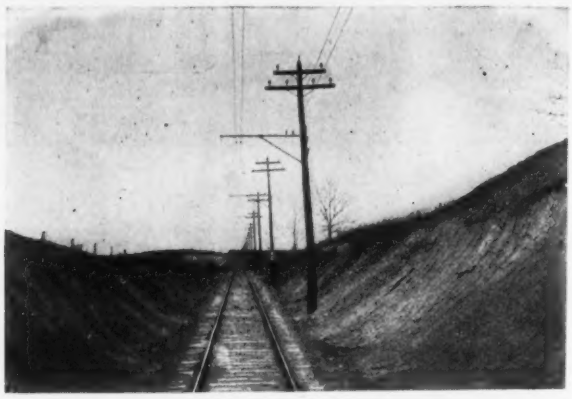


FIG. 7.—LINE CONSTRUCTION BETWEEN OXFORD AND ATLAS.

each set being on the upper cross-arm and the other two on the lower arm at equal distances from each other and from the upper wire.

The road runs over private right of way, and as the country is quite level, long, straight stretches of track occur where speed of 40 to 50 miles per hour are frequently attained. The Atlas substation is a duplicate of the one just described, except that it being located in a small station, the freight and waiting rooms have been omitted in design of the station, and the freight business is handled in the rotary converter room.

The alternating-current transmission ends at Atlas, but the substation feeds over the 600-volt lines, nine miles further to the city of Flint. However, it is to be noted that further extensions of the road are not limited by the transmission system. Further demand for power in Flint or for more distant extensions can be met by an extension of the high-tension system to new substations, and the installation of additional generators in the power house.

The Cost of Street Opening.

President Cantor, of the Borough of Manhattan, New York, will bring before the Board of Estimate and Apportionment the motion to make the necessary appropriation to construct a pipe gallery in lower Broadway. William R. Corwine, secretary of the Committee of Pipe Galleries of the Merchants' Association, in advocating the proposed improvement yesterday, quoted a report made by Wisner Martin, engineer of sub-surface structures, on the subject of street openings, showing that such openings for house services and for repairs for electricity, gas, steam and water pipes, amount to about 44,589 square yards in a year, and that the cost is $209,710. The same report also showed that in the opening of streets for the laying and overhauling of mains 125,882 square yards of surface were removed, at a cost of $345,769 a year. "We have, therefore," said Mr. Corwine, "a gross total of 170,471 square yards removed at a total yearly cost of $555,479. That is in the Borough of Manhattan alone. The use of pipe galleries for pipes now under ground will undoubtedly save the city a great deal of money. It would certainly save a great deal of the inconvenience now caused to people using the streets. If pipes were in galleries access could be had to them through manholes or openings in the Rapid Transit structure."

Telephony in Street Car Dispatching.

Those who attend the American Street Railway convention at Detroit, next week, will have an excellent opportunity to study the application of telephony to the important work of car dispatching. The work done there exemplifies what can be done elsewhere and what has already been successfully attempted under corresponding conditions in other cities. All the electric interurban railways radiating from Detroit operate under dispatcher's orders given by telephone. The methods used by the three different managements which operate these lines are very similar and differ only in detail. In each case telephones are located in cabins or booths at sidings along the line, and no attempt is made to carry telephone instruments on the cars. The orders are all received orally, and no written record is

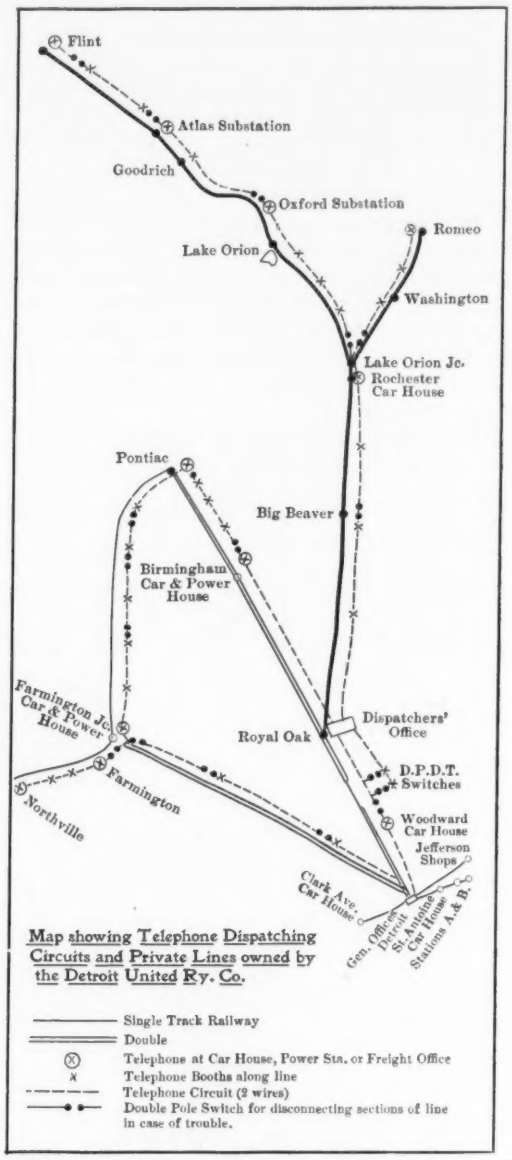


FIG. 1.—MAP OF TROLLEY TELEPHONE SYSTEM.

kept on any of the lines. The Detroit United Railway system operates all its interurban lines, except the Wyandotte Division, from one dispatcher's office, located at Royal Oak Junction, 14 miles from Detroit. From this point the dispatcher has telephonic communication with the whole interurban system controlled by the Detroit United Railway. His office is on the second floor of the freight office and waiting room at that point, and commands a good view of the interurban lines which approach it from three directions. The location of this office with reference to the Detroit United system can be seen from the map, Fig. 1, which shows the telephone dispatching system of that company, except the Wyandotte Division, which has Bell telephone lines and instruments. From this map the location of all the telephone booths is shown, booths being located at every siding on the system. Although the telephone lines are essentially for train dispatching, they are also used in a limited way for trans-

action of general business. Their use, however, for this purpose is not encouraged, and it is understood that train dispatching business has the right of way over anything else on these telephone lines. Should a line be in use for a conversation other than dispatching, the employees have strict orders to cease talking the instant a train crew calls up the office for orders, and not to resume conversation until orders have been given. The dispatchers work in three watches. They are men thoroughly familiar with the business as carried on by steam railroads, and keep regular train sheets.

Orders are received at the telephone booths of this company by the conductors and are repeated to the dispatcher by the conductor.

FIG. 2.—CAR DISPATCHER'S OFFICE.

The motorman must be within hearing to hear the order repeated back. The telephone lines are mainly No. 10 Washburn & Moen gauge B. B. iron wire. In the city and when passing through trees, a waterproof insulator is used, and the lines outside the city are run on brackets with pony insulators, and are transposed every ten poles, except under high-tension, alternating-current lines, where they are transposed every five poles. The Hemingray transposition insulator is employed for this purpose. The standard telephone equipment for booths consists of Stromsberg-Carlson telephone instruments, with an 1,800-ohm ringer, a five-bar magneto generator, which will ring through 60,000 ohms' resistance. The instrument in each booths are connected with the line through a double-pole, single-throw baby switch. This switch is open when the telephone is not in use, and strict orders are given that it shall be so opened, in order

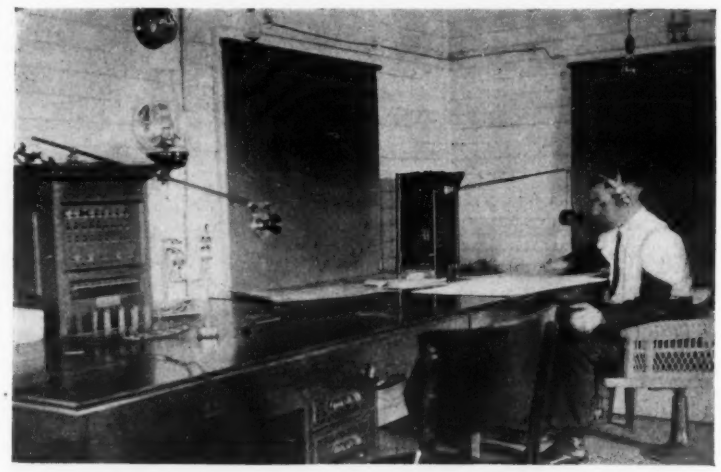


FIG. 3.—INTERIOR OF TELEPHONE CAR DISPATCHING OFFICE.

that the line may not be rendered inefficient by having a large number of instruments bridged across it. At the dispatcher's office, shown in Figs. 2 and 3, there are two duplicate switchboards, so that in case anything goes wrong with one the other can be switched in. The dispatcher has four dispatching lines entering his office, and connection with any one is established by simply throwing an operator's switch. The plugs on the operator's switchboard are for making connections between different dispatchers' lines when they are used for general business. In the ordinary operations the dispatcher has only to throw his keys to connect his head telephone with the various lines. As seen by the map, Fig. 1, communication can be had with many points on the system from two directions. Double-pole switches are placed in a line at frequent intervals, as shown. In case a line is short-circuited or grounded at a certain point, the switches on both sides of the trouble can be opened and the work of dispatching can then be carried on without interruption.

In the city the telephone lines are often suspended from the electric railway span wires by means of porcelain insulators. In some cases a common porcelain insulator is used tied to the span wire with the telephone line wire pulled through the hole in the center, and in other cases a porcelain insulator especially made for this kind of work has been put up. This location for the telephone wire keeps it from interference with the heavy foliage. The greatest care is exercised to maintain telephonic communication without interruption, and in case there is trouble on any of the telephone lines, its repair has the preference over any other work. The dispatcher not only governs the operation of cars on interurban lines, but is very helpful to all departments because he is in closer touch than anyone else with the actual operation of the entire system. He receives the first reports of troubles along the line, both large and small, and is of great assistance to track and overhead departments by reporting to them defects reported by trainmen.

The number of passenger cars dispatched on the interurban lines on the ordinary schedule is 22. On special occasions this may be increased to 40. To this should be added the work cars, freight cars and supply cars, which, being irregular, run as extras, and so add to the dispatcher's cares much more than in proportion to their numbers. On the Rapid Railway system the telephones used for dispatching are rented from the Bell Telephone Company and are maintained by that company. The orders are received by the motorman, and are carefully repeated back to the dispatcher. The conductor stands close at hand, while the motorman repeats the order back, and then the conductor also steps to the telephone and repeats back the order. On the Detroit, Ypsilanti, Ann Arbor and Jackson Railway, the orders are received and repeated back by one man (the motorman), who repeats them afterward to the conductor.

Electrical Supply from Water Power.

BY ALTON D. ADAMS.

MASSACHUSETTS is not so liberally provided with great water powers as are some of the other New England States. Furthermore, the high density of population in this State and its numerous manufacturing interests tended to an appropriation of its most important waterfalls for other purposes, before electrical supply systems grew to be of importance. In spite of these facts, the considerable elevation of a large portion of the area of the State, which includes two watersheds, each extending across its entire width from north to south, and with a height above tidewater of 1,000 to 2,000 feet, and the numerous small rivers that flow down its slopes, offer many moderate water powers for the use of electric systems. These powers, often distant five to twenty miles from important centres of population, are rendered doubly available by the ease with which electrical energy is transmitted.

The object here is to point out the extent to which these small water powers, and, in a few cases, parts of the larger ones have been applied to systems of electrical supply in Massachusetts. No mention is here intended of those numerous cases where an electric plant, devoted to the service of a factory or other private purpose, is driven by water power, but only those water-driven electric plants are considered which operate for purposes of public supply. In a discussion of these plants it seems desirable to consider the steam engine capacity as well as the horse-power of waterwheels included by each of them. Accordingly the accompanying table has been constructed to show the number and location of electrical supply systems in Massachusetts, that use water power, and the capacity of steam engines and waterwheels in each.

Inspection of this table shows that eighteen electrical supply systems, distributing energy in a somewhat greater number of towers and cities, are now operated entirely or in part by water power. Four companies, the Franklin, Great Barrington, Medway and Shelburne, depend entirely on water power, and have wheels with an aggregate capacity of 990 horse-power. The largest of these purely water-driven plants is that at Great Barrington, with wheels

of 750 horse-power capacity. Much the largest application of water power to a public electrical supply system in the State is that at Springfield, where the wheels have a capacity of 2,835 horse-power. Of the fourteen plants using both steam and water power, seven have greater capacities each in waterwheels than in steam engines, indicating probably that much the greater portion of the total load, on an average, is carried by the water powers.

June 30, 1901.
Electrical Supply Systems in Massachusetts Using Water Power.

Name of Company.	*Places Supplied.*	*Power Steam Engines*	*Power Water Wheels*
Union S. Adams	Townsend	50	30
Attleborough Steam & Electric Co.	Attleborough	750	79
Central Massachusetts Electric Co.	Palmer, Monson, Warren.	450	735
Franklin Electric Light Co.	Turner's Falls	....	100
Great Barrington Electric Light Co.	Great Barrington	....	750
Grafton Electric Co.	Grafton, Sutton	75	109
Holyoke Water Power Co.	Holyoke	800	1,120
Lawrence Gas Co.	Lawrence, North Andover, Methuen	3,415	1,691
Lee Electric Co.	Lee	205	145
Medway Electric Light & Power Co.	Medway	....	55
Natick Gas & Electric Co.	Natick, Wayland, Wellesley	875	710
Orange Electric Light Co.	Orange	185	408
Rawson Light & Power Co.	Leicester	210	30
Shelburne Falls Elec. Lt. & Power Co.	Shelburne Falls	....	85
United Electric Light Co.	Springfield	1,650	2,835
Weymouth Light & Power Co.	Weymouth	820	400
Winchendon Elec. Light & Power Co.	Winchendon	125	150
Municipal Plant	Middleborough	150	125

This conclusion seems to follow from the fact that where the capacities of wheels are such that they require the entire flow of a stream during periods of high water, they cannot be operated at their full power for the whole year. If the load of electric generators on waterwheels is kept nearly up to the full capacity of the latter, as is desirable, it follows that quite a large per cent. of the total waterwheel capacity must be represented in the power of reserved steam engines. Where the engine capacity is less than that of waterwheels in a plant, and a large per cent. of the engine power must be held in reserve for periods of low water, the capacity of engines for which a load can be found during periods of ample flow must be relatively small, under ordinary conditions.

For the seven plants where the capacities of waterwheels exceed those of engines in each case, the total for engines is 4,700, and for waterwheels 7,048 horse-power. In the seven plants where the engines have the grater capacities, their total is 3,060 horse-power, and that of the waterwheels 1,519 horse-power. Engines aggregating 7,760, and waterwheels 8,567 horse-power are included in the fourteen plants, a total of 16,327 horse-power. If the powers of these wheels are reduced one-third in times of scant water, $8,567 \div 3 = 2,855$ horse-power of the engine capacity must be held as a reserve, so that the maximum load for these plants in the dry season may only be $16,327 - 2,855 = 13,472$ horse-power. Of this maximum the waterwheels will then furnish 42 per cent., and the engines 58 per cent.

For periods when the flow of water is ample, which is true during about two-thirds of the year, if the maximum load remains the same as before, the waterwheels carry 64 per cent., and the engines 36 per cent. of the load. Considering the output of energy for the entire year on this basis, the waterwheels supply $.33 \times .42 + .66 \times .64 = 56$ per cent., and the steam engines $.33 \times .58 + .66 \times 36 = 44$ per cent. of the total. It is good practice to provide steam power in excess of the maximum load, to an extent exceeding one-third of the capacity of the waterwheels, in order to be sure of sufficient reserve in very dry seasons. This practice would tend to increase the portion of the total yearly output of energy supplied from waterwheels in these cases. Including the four electrical systems operated entirely by water power, the total capacity of the wheels engaged in this service in Massachusetts is 9,557 horse-power. With efficiencies of 75 per cent. for the turbines and 90 per cent. for the electric generators, this wheel capacity is sufficient for an output of 4,836 kilowatts.

Application of water power to electrical supply has gone on much faster than the general growth of the industry. In Massachusetts, during the fiscal year of 1889, water power was employed in four systems of electrical supply, but in 1901 this number had increased to eighteen systems. In the former year the total capacity of water wheels in use by electric lighting systems was only 545 horse-power. For 1901 this total stood at 9,557 horse-power, or 17.5 times the capacity in the earlier year. Up to and including 1894 the application of water power went on rather slowly, the total being 2,085 horse-power in that year, but since then progress has been more rapid.

Horse Power of Water Wheels.

	1889	1890	1891	1892	1893	1894
Holyoke	370	370	370	1,120	1,120	1,120
Middleboro	125	125	125	125	125	125
Turner's Falls	....	40	40	100	100	100
North Attleboro	30	30	30	30	40	40
Lee	....	60	60	60	60	60
Leicester	20	60	60	60	60	60
Natick	....	....	....	....	140	280
Palmer	....	....	....	....	....	300

	1895	1896	1897	1898	1899	1900	1901
Middleboro	125	125	125	125	125	125	125
Holyoke	1,120	1,120	1,120	1,120	1,120	1,120	1,120
Turner's Falls	100	100	100	100	100	100	100
Lee	60	60	60	60	145	145	145
Leicester	60	60	30	30	30	30	40
Natick	560	180	430	430	430	710	710
Palmer	360	360	360	510	510	735	735
Grafton	116	109	109	109	109	109	109
Gt. Barrington	640	640	640	640	750	750	750
Attleboro	40	79	79	79	79	79	79

Horse Power of Water Wheels.

	1896	1897	1898	1899	1900	1901
Orange	150	408	408	408	408	408
Springfield	....	1,890	2,835	2,835	2,835	2,835
Shelburne Falls	....	85	85	85	85	85
Townsend	....	....	....	30	30	30
Medway	....	....	....	56	55	55
Winchendon	....	....	....	150	150	150
Lawrence	....	....	....	....	1,691	1,691
Weymouth	....	....	....	....	400	400

During the five years from 1889 to 1894, the capacity of waterwheels added to electrical supply systems was 1,540 horse-power, or an average of 308 horse-power yearly. In the seven years from 1894 to 1901 the added waterwheels amounted to 6,472 horse-power, or 924 horse-power in each year on an average.

Up to 1896 the electrical system at Holyoke had the largest capacity of waterwheels of any in the State, namely, 1,120 horse-power; but in 1897 Springfield installed wheels of 1,890 horse-power and took first place. It is a notable fact that no system which has once used water power has abandoned it. The small plant at North Attleboro up to 1894 was moved to Attleboro thereafter, but continued to use water power. Of the eighteen plants recorded, ten have increased the capacity of their waterwheels since first installed. The three plants at Holyoke, Springfield and Lawrence represent a combined capacity of 5,646 horse-power in waterwheels. And this is only the beginning of water power in electrical supply.

Anglo-Belgian Telephony.

A dispatch from London says: About Nov. 1 the longest submarine telephone line in the world will opened between England and Belgium. The principal part of the cable has been laid, terminating on the English side in St. Margaret's Bay, near Dover, and on the Belgian side in the little harbor of La Panne. It now only remains to make shore connections. The length of the cable is 63 miles; it is on the double circuit plan, and cost about $5,000,000, while its complete installation will take nearly twice as much. The entire enterprise was conceived and has been carried through by the General Post Office of London. Its distinct advantage over other lines between the Continent and England is that, through the Anglo-Belgian communication, telephone subscribers all over Belgium will be able to speak from their homes with subscribers in any part of England. The expense of maintaining the new line will be equally borne by the governments of England and Belgium. Although on the surface this Anglo-Belgium enterprise appears to have no political significance. still, it should not be forgotten that the status quo of Belgium is guaranteed by Great Britain, who regards the "low country" in question as a sort of buffer state separating her from Germany and Russia. At any rate, the line will be in perfect accord with the present attempt of the British Government, working in sympathy with certain East England industrial interests, to have Dover regain something of her old-time importance as a commercial center.

Metallic Conduction and the Constitution of Alloys.

BY JOHN ALEXANDER MATHEWS, PH. D.

IN a paper recently presented by the author, before the Iron and Steel Institute[1], this subject was touched upon to a slight extent, and it was stated therein that "the evidence thus far, though insufficient, leads me to hope that a law will be found connecting atomic concentrations and the specific conductivities of added metals with the resulting change in the conductivity of the principal metal. Before this can be possible, more must be learned about the intermetallic chemical relations of alloys." This opinion was based upon the recent work of Barrett, Brown and Hadfield[2], Le Chatelier[3] and the classic researches of Matthiessen, together with some recent measurements by myself. For the most part steel alloys have been studied. It was also pointed out that a study of quenched, rather than annealed materials, might be profitable, for if alloys are to be considered as solutions, it is probable that some atomic relation affecting their resistivity exists. Now quenching tends to keep all the constituents of an alloy in a homogeneous condition, resembling that which existed while the alloy was molten, while annealing, particularly of steels, promotes segregation of the constituents in a way analogous to precipitation in ordinary solutions. The constitution of alloys has been very fully discussed in two recent papers by the author[4], and the perusal of either of them by readers not familiar with recent work upon this subject may help to make clear what follows.

Nearly simultaneously with the presentation of my paper to the Institute, there appeared in England a later paper by Prof. Barrett[5], the distinguished physicist, whose name is associated with the discovery of the phenomenon of recalescence in steel, and one in Germany, by Mr. Carl Benedicks[6], both of which tend to confirm in part the opinion quoted at the beginning of this article. At the same time, however, they lead to the conclusion that it is not a new law, but the extension of an old law to a field in which it was not known or supposed to apply—the law of Mendelejeff and Newlands that "the properties of the elements are a periodic function of their atomic weights."

It will be remembered that in studying the effect of various elements on gold, Roberts-Austen[7] found that the mechanical properties of that metal were, in general, changed in a manner proportional to the atomic volumes of the added element. The larger the atomic volume, the more deleterious was its effect upon gold. This law only applies to small percentages of added impurities, *i. e.*, to those which may be supposed to yield a single solid solution, and its general applicability is further interfered with by the individual chemical behavior of the added metal toward the principal metal. The formation of a definite intermetallic compound by the two metals would naturally produce a different effect than a simple solution of one metal in the other, but such a condition in no way invalidates the law, for it was only supposed by its discoverer, Sir William Roberts-Austen, to apply to dilute, solid solutions. Osmond's work seems to show that the influence of elements on iron is in accordance with the periodic law. The close relation between the periodic law and Roberts-Austen's law of atomic volumes is seen when we recall that atomic volume = atomic weight ÷ specific gravity.

In Professor Barrett's recent paper, he points out a relation existing between the increase of electrical resistivity in iron alloys and the specific heat of the added element. But the specific heat multiplied by the atomic weight, in most cases, gives a constant; hence, the increased resistivity is as closely related to one as to the other. The alloys studied by Prof. Barrett were the very excellent series prepared by Hadfield, and included a large number of alloys of many elements with iron. In their earlier paper on the conductivity of these alloys, Messrs. Barrett, Brown and Hadfield state that, "an approximate estimate of the quantity of carbon in any specimen of carbon-steel might be quickly obtained by a determination of the electrical conductivity of the particular sample, provided that the other constituents, especially silicon and manganese, were practically uniform throughout the specimens. On the other hand, from the electrical conductivity of samples of steel, in which the percentage of carbon only is known, we can infer the purity or otherwise of the samples." This very interesting observation might often be applied advantageously in testing materials.

In discussing the relation between conductivity and specific heat, Prof. Barrett says: "From the conductivities of the specimens their specific resistances were calculated; these were plotted against the percentages of the added element. A series of fairly smooth curves were thus obtained for each alloy." There is obviously no connection between the curves thus obtained and the conductivities of the added metal—for example, aluminum produced the greatest effect and tungsten the least; and aluminum, which is a better conductor than nickel, produces a greater increase in resistance than nickel. Neither is there any connection—as Prof. Barrett observes—between physical hardness and the conductivity; the hard manganese and tungsten steels are better than the soft silicon and aluminum steels for equal percentages of impurity. The following table, from his paper, shows the approximate increase in resistance (in microhms per cubic c.c. at 18° C.) of annealed iron by adding to it the metals named in the first column of the table:

TABLE I.—(BARRETT).

	Per cent. of Added Metal.		
Alloys of Iron with:	2.	3.	5.
Tungsten	4.0	5.0	6.0
Nickel	7.0	9.0	13.0
Chromium	10.0	11.5	14.0
Manganese	16.0	18.0	24.5
Silicon	26.0	34.0	49.0
Aluminum	28.0	36.0	54.0

From this table it will be noticed that the increase of resistivity decreases with each addition. In a second table, Prof. Barrett shows the approximate increase of resistance for one per cent. of added metal, and compares this with the specific heat of the added metal. I have modified this table by the omission of carbon and by the introduction of more recent values for the specific heats of chromium and aluminum, the new values in both cases agreeing more closely with those required by the law of Dulong and Pettit.

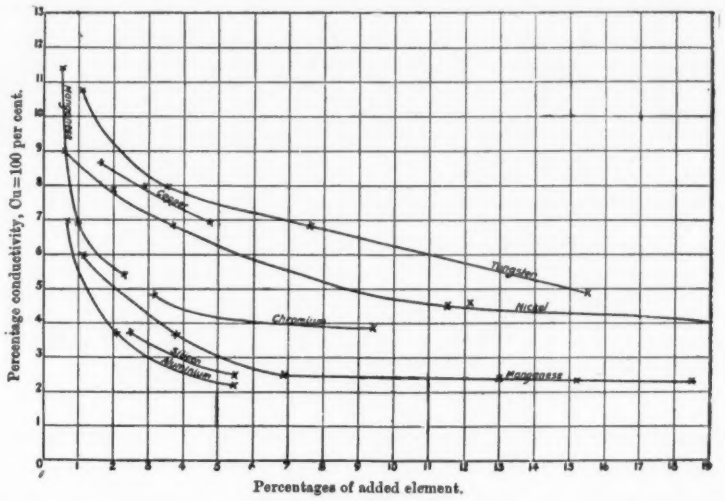


FIG. I.—BARRETT CURVES.

TABLE II.—(BARRETT).

Alloy.	Inc. in Res. 1%.	Spec. Heat.	Atomic wt.
Tungsten	2.0	.035	184.
Cobalt	3.0	.107	59.
Nickel	3.5	.109	59.
Chromium	5.0	.121	52.
Manganese	8.0	.122	56.
Silicon	13.0	.183	28.
Aluminum	14.0	.227	27.

It must be recalled that in dealing with percentages as high as those of the first table, we are not sure that the added metal remains in solution, especially in the annealed samples.

Some of Prof. Barrett's curves are shown herewith. In the diagram I (Fig. 1) the added elements are expressed in ordinary percentages, as given by him originally. The second diagram shows the result of replotting them in atomic percentages, the calculations being made upon the basis of the number of atoms of added metal in 100

[1] "A Comparative Study of Some Low Carbon Steel Alloys." J. I. & S. I., 1902, vol. I.

[2] Sci. Trans. Royal Dublin Soc., vii, p. 67.

[3] Bull. Soc. d' Encouragement.—III, p. 743.

[4] "Alloys as Solutions." The Mineral Industry. Vol. X, or "Upon the Constitution of Binary Alloys." J. Frank. Inst., Jan.-March, 1902.

[5] Proc. Royal Soc., LXIX, p. 480.

[6] Zeits. f. physikalische chemie, 1902, vol. 40, p. 545.

[7] Phil. Trans. of the Royal Soc., CLXXIX, p. 339.

atoms or iron. The dotted portions of diagram (Fig. 2) have no connection with the subject immediately at hand.

In studying the relation of electrical resistance to the constitution of the conducting alloy, we must always bear in mind what a complex substance a steel alloy is: that it always contains carbon, manganese, silicon, sulphur and phosphorus; that the iron itself may exist in two or three allotropic conditions; that the limits of solubility of various elements in iron are in most cases unknown, and that the intermetallic compounds of iron with another metal, or of two metals with carbon forming a double carbide, have been very imperfectly worked out.

Yet, notwithstanding these complications, a broad view of the existing evidence leads to the idea that the atomic law is in some way connected with the problem. Prof. Osmond, in discussing the author's paper to the Iron and Steel Institute, takes this view of the subject when he says: "It was remarkable that Mr. C. Benedicks should have arrived independently and simultaneously at the conception of the idea of atomic equivalents of dissolved bodies. It was true there was some considerable discrepancies between the results of Benedicks and Mathews, but there was nothing very surprising in these discrepancies, any more than in those on which the author (Mathews) commented as existing between results of M. Le Chatelier and other physicists in the case of tungsten, molybdenum and chrome-steels.

"If the law of atomic weights was exact, it was applicable, as its very enunciation implied, only to the dissolved fraction of the alloyed

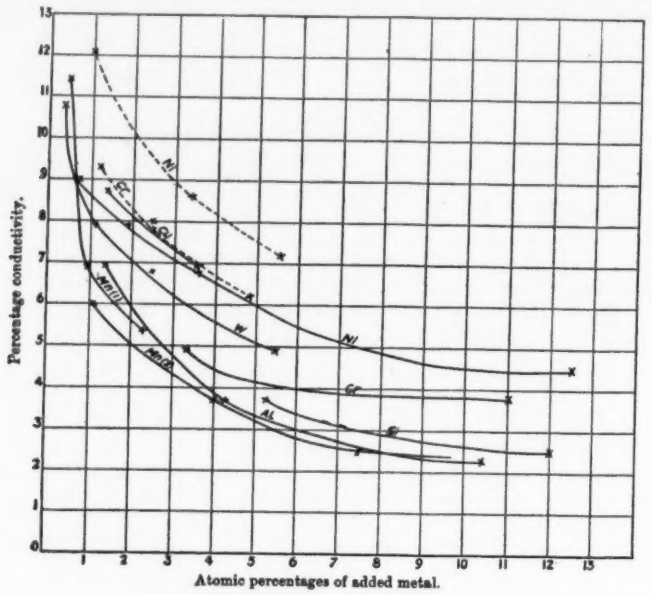


FIG. 2.—MATHEWS CURVES.

substances, but this fraction varied according to the treatment, and was unknown in many cases. Notably, chromium and tungsten, and probably molybdenum, too, would form double carbides, which, when liquated, would have but a very weak influence. Before concluding, it would be necessary to know in each particular case what was dissolved and what was not, and also what was the state of the substance in solution. These were questions to which one could but seldom find an answer, and much investigation, as Dr. Mathews rightly said, was still necessary." It was in the hope of stimulating further work upon this interesting problem that we venture to bring it to the attention of electricians, hoping—as we have elsewhere stated in regard to these views—to "provoke discussion, and, more especially, thought and research in this important field. Their confirmation would be of great interest; their refutation upon experimental evidence would doubtless produce some other and correct explanation."

At the time that remark was made, Mr. Benedicks, in the University of Upsala, was bringing forth the most conclusive evidence that for small concentrations the increase in resistivity of steel is a function of the atomic weight, *i. e.*, equi-atomic solutions of metallic elements in iron produce equal increase in electrical resistance.

Mr. Benedicks determined the electrical resistance of a number of samples of steel which had been carefully analyzed. They contained varying quantities of carbon, silicon, manganese, sulphur and phosphorus, the last two elements being low and fairly uniform. The steels were tested in both the hardened and annealed state. From his determinations, the author found that one atomic per cent. of various elements dissolved in iron produces an increase in resistance which is equal to 5.9 microhms per cm^3. The author also calculated that the resistance of absolutely pure iron would be 7.6 microhms per cm^3, but this value is lower than has ever been obtained experimentally, for perfectly pure iron has not been investigated. By means of the following formula, it was found possible to calculate the resistance of steel with considerable accuracy:

$S = 7.6 + 26.8\ \Sigma C$, in which S = resistance in microhms per cm^3, and $\Sigma\ C$ = % foreign substances calculated as equivalent quantities of carbon.

But in order that this formula be applicable, it was necessary to ascertain the effect of carbon itself upon the conductivity. This Mr. Benedicks has done very skillfully. It is now generally understood that carbon combines with iron to form a carbide, Fe_3C. This exists in annealed steels in a condition easily recognizable under the microscope, and is known to metallographists as "cementite." When steel is heated to temperatures above 700° C. and cooled suddenly, no cementite appears, but under the microscope, at high magnification, a structure known as "martensite" is seen. The carbon in this condition may be combined or simply dissolved without combination. Prof. Arnold thinks that a sub-carbide, $Fe_{24}C$, exists in hardened steel.

However, when hardened steel is reheated and slowly cooled, cementite appears, and the other micrographic constituent is known as "ferrite." This has usually been considered to be *pure* iron, and the combined ferrite and cementite, when existing in alternate bands or layers, constitute the "pearly constituent" of Dr. Sorby, now called "pearlyte." Mr. Benedicks shows that ferrite is not carbon-free iron, but that annealed steels, containing from .40 to 1.70 per cent. carbon, consist of cementite and iron containing about 0.27 per cent. of dissolved or hardening carbon. This constituent may be identical with the "sorbite" of Osmond. The segregated carbon, in the form of cementite exerts little influence upon the conductivity This statement does not seem to accord with that of Le Chatelier, who gives the resistance of ferrite as 9.5, and cementite (Fe_3C) as 45.

When a low carbon steel—less than 0.40 per cent. carbon—is annealed, cementite separates, but the accompanying ferrite contains less carbon than 0.27 per cent. For example, Mr. Benedicks states that the ferrite of a .20 carbon steel would contain 0.06 — 0.07 per cent. of dissolved carbon. Benedicks' work confirms the chemical researches of Osmond and Werth, Carnot and Goutal, Brustlein, Arnold, and Stansfield in regard to the existence of 0.27 per cent. of hardening carbon in solid solution in annealed high-carbon steels. All this work strengthens the author in the opinion he has held and expressed repeatedly, that in the separating or crystallizing out of the constituents of any alloy, no pure metal ever separates but metal containing more or less of the other constituents of the alloy in solid solution. It seems, too, that in Benedicks' confirmation of the atomic equivalence of the elements in their effect upon conductivity, we have presented some new evidence in favor of the opinion expressed by Professor Ramsey, in 1889, "that it would appear legitimate to infer that in solution, as a rule, the atom of a metal is identical with its molecule."

As regards the exact nature of the phenomenon of conductivity in metals and alloys, very little is known. The beautiful theory of electrolytic conductivity in ordinary liquid solutions seems to have nothing in common with metallic conduction. In a way, these two kinds of conductivity seem to be opposed to each other, for while the conductivity of a pure liquid is increased by the presence of dissolved matter in it, a pure metal becomes a much poorer conductor if another element is added to it. Dewar and Fleming's researches showed that the resistance of pure metals decreased with falling temperatures, and there was evidence that at the absolute zero the resistance would be *nil*. In the case of alloys, no such evidence was afforded; they seem to follow some other law. What is true in regard to electrical conductivity probably holds for thermal conductivity as well. Kohlrausch showed that for high carbon steel, low carbon steel and wrought iron the ratio between these two kinds of conductivity is close.

The electrical resistance of steel at high temperatures furnishes one of the evidences of the allotropy of iron. Le Chatelier found two reversible transformations in the conductivity of a certain sample of malleable iron at 730° C. and 855°C. These temperatures correspond closely to the "breaks" in the cooling curve of mild steel,

designated by Osmond as *Ar 2* and *Ar 3*, *i. e.*, in slowly cooling such a sample of steel there occur two evolutions of heat at certain temperatures. These evolutions of heat occur in the purest carbonless iron. In iron containing carbon, their point of occurrence is affected by the presence of that element, but since its presence is not the cause of their occurrence, they have been thought to indicate molecular or allotropic changes in the iron itself. As has been shown for iron, the first additions of any other element produce greater increase in resistance than any subsequent additions. It is these first small additions that may be supposed to remain in solid solution, and to act most deleteriously upon the conducting power of the iron. Matthiessen showed that the conductivity curves for most pairs of metals—excluding the metals lead, tin, zinc and cadmium—is of the shape of the letter U. Alloys whose compositions lie along the part of the curve where it is nearly vertical, are those in which a single solid solution is most likely to occur. Intermediate compositions usually consist of at least two constituents crystallizing together in some sort of a conglomerate of solid solution, intermetallic compound, eutectic, etc. However they crystallize, each constituent is more or less saturated with the other at the temperature of solidification. All such alloys conduct poorly, but it is not known that the size of the grain or the number of boundary faces between contiguous grains influences the conductivity directly. The presence of such constituents, microscopically discernable, has suggested to Lord Kelvin the idea that the increased resistance may be due to thermo-electric effects, caused by the passing of the current. He says. "the temperature thus arising increases until the conduction of heat through the laminæ balances the Peltier effect at the junctions, and it gives rise to a thermo-electric force opposing the passage of the current." Now, if such effects take place at points of contact between laminæ of relatively large size and of different compositions, why might not the same phenomenon occur between much smaller laminæ, and why might they not occur between the atoms themselves—in other words, why will not the explanation hold good for solid solutions? This would account for a greater effect from a dissolved than from a segregated substance.

In the case of non-ferrous alloys, there is some evidence in favor of the existence of an atomic relation governing conductivity. These alloys would be the easiest to study by way ot confirmation of the evidence afforded by steel, because they can be obtained in a greater degree of purity. From existing data, however, something in favor of the atomic theory as applied to metallic conduction has been gathered. This we will summarize briefly in conclusion. The only two metals which we know to be perfectly soluble in each other, and which never separate into two microscopic constituents, are silver and gold. The highest degree of mutual solubility of which we can conceive would be afforded by an alloy of the composition, *Au-Ag*, *i. e.*, an equi-atomic alloy. It is precisely this one which has the highest resistance. Alloys whose compositions are represented by the atomic values Au_4Ag and Ag_4Au conduct about equally well. In the investigations of the Reichsanstalt upon the conductivity of nickel-copper alloys, it was found that the alloy consisting of almost equal atoms of nickel and copper had the highest resistance. In the case of copper-silver alloys this does not hold good, but, nevertheless, the solution theory in regard to resistance is confirmed. Matthiessen found the highest resistance of silver-copper alloys to be afforded by Levol's alloy, which contains about 28 per cent of copper.

This is the one alloy of copper and silver, which on slow-cooling in mass, does not segregate, but is of uniform composition throughout. It is, in fact, the eutectic alloy, and a microscopic examination of it reveals the fact that it is composed of two constituents. One of these we believe to be a saturated solid solution of copper in silver, and the other a saturated solid solution of silver in copper. Hence, we have two, instead of one, saturated solid solutions crystallizing side by side, and the lowest conductivity is afforded by them just as an alloy of the composition *Au-Ag* gives the lowest conductivity of all gold-silver alloys. Any addition of silver or copper to Levol's alloy is equivalent to diluting one or other of the solid solutions of which it consists, and the conductivity is improved thereby.

If the conductivity of a series of steels containing practically a constant percentage of manganese, but varying in carbon, be measured in both the hardened and annealed conditions, and the results plotted, it will be found that the quenched steels not only have a higher resistance, but that the curves diverge from each other directly in proportion to the carbon content. The hardening of steel changes the carbon from a segregated to a dissolved condition. This explains the divergence of the curves for the increasing amount of dissolved carbon, increasingly augments the resistance. If, however, steels of constant carbon and varying manganese be similarly treated, the curve of the quenched specimens will fall below that of the annealed specimens, but will be practically parallel to it.

The difference between the two curves in this case is due to the retention of all the carbon in the dissolved state, but the effect due to increasing manganese is the same in both conditions, for it crystallizes isomorously with the iron, and—for low percentages—is contained in the iron crystals, whether they are quenched or not.

From what has preceded, it will be seen that although electrolytic and metallic conductivity are so different in nature, yet the question of solubility seems to affect or control metallic conduction, and there exists an atomic relation between the effect of different dissolved substances upon the conductivity of the principal metal or solvent. All the recent work upon alloys tends to strengthen the idea that alloys in many of their properties resemble liquid solutions, and with a brief summary of these points of resemblance we will close. Graham and Roberts-Austen have shown that at temperatures much below their melting points, metals diffuse into one another, like a salt into water. Like liquids, metals may or may not be perfectly miscible. In the latter case, Dr. Alder Wright has shown that a fused mass of two immiscible metals on cooling separates into layers, and that the layers do not consist of pure metals, but that each metal retains a little of the other in solid solution..

In general, solubility increases with the temperature. Professor Spring and others have shown that metals will flow under pressure, and that by the same means, mixed metals may or may not react chemically when thus brought into intimate association. Molecular mobility increases with the temperature in metals as well as in liquids. Upon cooling molten binary alloys, the phenomena attending solidification are strongly suggestive of the behavior of freezing salt solutions. It has been shown by Heycock and Neville that the depression of the freezing point of one metal by the addition of another to it follows the laws of Coppet and Raoult. The eutectic alloy, of Guthrie, is the analogue of the "cryohydrates" of physical chemistry, and Roozeboom, Le Chatelier and others have shown that the phase rule of Gibb applies quite as well to the explanation of questions of equilibrium in alloys as it does to the explanation of similar problems in regard to liquids and gaseous mixtures.

In view of all this evidence, it may not be surprising, but it is, nevertheless, a very interesting coincidence that almost simultaneously three workers of different nationalities in three different countries should have observed independently another confirmation of the periodic relation of the elements and of the general applicability of the solution theory to the explanation of the properties of alloys.

Telpherage Mails in Italy.

BY CESARE PIO.

The Minister of Posts and Telegraphs of the Italian Government is at present devoting great attention to a new system of postal communication invented by Mr. Piscicelli, an engineer from Naples. Tests on this new system have commenced, and features of it are exhibited on the Margherita Hall under the Main Arcade in Naples. The idea of Mr. Piscicelli is a very simple one, and his system is destined perhaps to revolutionize all systems of land and rural postal communications in the world. Mr. Piscicelli's invention consists in building up a small aerial railway whose track is made of steel wires, supported at the height of 45 feet on poles 300 feet apart. Small motor cars run suspended to these wires, and are fed with electric current. The motors are designed so to communicate to the car a speed of 400 km. (250 miles) an hour. With a speed of this kind, all the Italian post offices would be in communication on a very rapid schedule.

In Rome a main post office is to be installed in conjunction with eight or ten sub-stations, each sub-station consisting in a tower 75 feet high, provided with a mailing box at the bottom. All letters mailed are automatically stamped with indications of the month, day, hour and minute at which the letter was mailed. The letter is then conveyed to the top of the tower, where a special employee is in charge of putting all the mail in the small motor car, which is then sent to the General Post Office. Thence the mail is then forwarded to the different cities of Italy in less than two hours. Each

steel wire of the line is designed for carrying a weight of two tons. The motor cars for letters weigh 75 pounds, and the cars for printed matters are able to carry to 2,000 newspapers. With this scheme, it will be possible to read at 10 o'clock in Milan all newspapers printed at 8 o'clock in Rome. This would, of course, revolutionize the journalistic field. The cost of installation of this kind of plant reaches 3,000 lires ($600) per kilometer, or about $950 per mile. This is not very much when one thinks of the great economy realized in reducing the number of employed and the better facilities afforded to the public.

Proposed Developments of the Institute.*

BY CHAS. F. SCOTT.

Mr. Scott opened his address by saying that the day marked the entry of the Institute's newly elected officers on their duties, and the beginning of another year; and that it would be well to pause before entering upon the routine of regular work and to consider the functions of the Institute, its present status and its future possibilities.

The position occupied by the electrical engineer is unique. The science underlying his work is most fascinating and most fruitful. The applications of electricity are not confined to a limited field; they are almost universal—there is scarcely a branch of human activity that has not received a quickening touch. So rapidly have electrical novelties become commercial necessities and simple experiments evolved great systems that a new branch of engineering has been developed in a score of years. The scope of the electrical engineering profession has developed from trivial beginnings until it includes works of the greatest diversity and magnitude and far-reaching consequences, in industrial, commercial and social life. This development has been the result not of mere chance, but of a combination of favoring conditions. Faraday and Maxwell laid the foundations of electrical science and the general mechanical, industrial and scientific evolution of the nineteenth century gave the necessary opportunity and impetus to its commercial application. Electricity is usually a means, an agency, and is not in itself an end. In order that electricity may be applied, there must be that to which it can be applied. The electric motor, for example, would be of little consequence if there were no field for it—if there were no machine shops or mills, no elevators or street cars. It is because the steam engine has for a century been training men to use mechanical power, and because the existing methods of transmitting and distributing power have such fixed and narrow limitations, that the electrical system has so quickly taken its place between engine and lathe, between the waterfall and the loom. It is because the science of electrochemistry was advancing that the dynamo found a place in electrochemical industries, and, in turn, cheap electrical energy has accelerated electrochemical development. It is notable that the greater part of the power developd at Niagara Falls is used in electrochemical and allied processes, in the manufacture of aluminum, carborundum, sodium, chlorine, caustic soda, calcium carbide, phosphorus, graphite and barium hydrate, while in almost every case even the discovery of the process itself as well as the development of the industry has occurred since the work upon the power plant has begun.

It is a hackneyed theme—the infancy of electricity; and yet to obtain a just view of his position the electrical engineer must realize how brief compared with other branches of engineering is the experience upon which his work is based. Even the oldest of the electrical inventions, the telegraph, had its beginning when men now living were well-grown boys. The man who has been called the "Father of Electrical Engineering," whose theoretical and mechanical skill made the ocean cable a success, is still a vigorous worker, and quite recently the Institute was privileged to tender a reception to him, its honorary member, Lord Kelvin. It is not yet 27 years, the age required for full membership in the Institute, since the Centennial Exposition at Philadelphia gave an impetus to electrical invention and the telephone was made public. It was not until 1884, the year of the Philadelphia International Electrical Exposition, that measures were taken for establishing a national organization among electrical men, and the American Institute of Electrical Engineers was established. Its first president, Dr. Norvin Green, and half of its vice-presidents and managers were identified with the telegraph. The practical electricians of those days were telegraph men, but now a new generation has arisen to whom the click of the sounder is unintelligible.

The past 50 years, and notably the past decade, have witnessed a general activity of such magnitude that it marks an epoch in the world's history. And in this development, electricity has been foremost. I will not attempt to recount and catalogue what has been accomplished, in how many ways electricity has proven useful, the various purposes for which it is employed in industrial and manufacturing enterprises, nor to what extent the telephone, telegraph and cable have affected domestic, commercial, social and national life; I will not mention the results which the railway motor in city, suburban and interurban service is effecting in the cheapening of travel and the redistribution of population; I will not dwell upon the far-reaching effects in the economic world of an agent which makes possible the combination of formerly diverse interests by operating in one great system local and interurban railways, mills, shops, elevators, street lighting and indoor illumination; nor will I even attempt to sum up all these achievements and estimate by how much the results of human activity are increased through the agency of electricity. The point I do make is the magnitude of the work and the far-reaching responsibilities which have so quickly devolved upon the electrical profession.

Consider for a moment the financial aspect. It is estimated that the total investment in electrical applications outside of telegraphy and telephony at the time this Institute was founded, did not exceed $1,000,000. At the present time the estimated capitalization of electrical applications in the United States approximates $4,000,000,000. In other words, electricity represents about one-third the value of that represented by the investment in our steam railway systems. Speaking generally, this enormous expansion has been made possible by the electrical engineer, and, furthermore, the successful outcome of these investments depends upon his work. Even these figures, although they indicate the vast responsibilities which are entrusted to the electrical engineer, do not fully measure that responsibility, since they take no account of the importance of his work in the many industries and enterprises which use electrical apparatus in a subsidiary or auxiliary way, although it may be essential to their efficiency and success.

The work which the future has in store for the electrical engineer seems even greater. Scarcely a plan for future progress is proposed either by the practical and conservative business man, manufacturer or engineer, or by the sanguine promoter or the imaginative writer who portrays an Utopian civilization, which does not involve some application of electricity.

We are now at a time of general prosperity. Will this continue? Is prosperity a normal condition, or are successions of prosperity and depression inevitable? Continued prosperity requires high efficiency. Effort must not be wasted or dissipated. The ordinary activities and functions of industrial and commercial life must be efficiently performed, and energy must not be lost through great undertakings which fail in the execution or accomplish no useful result. Think for a moment how different the condition of Italy might be, had the energy which was expended in the construction of cathedrals been devoted to school-houses and an educational system. Consider what a drain upon the resources of a country, both in wealth and in men, are a large standing army and navy. Imagine the results had the hundreds of millions of pounds expended by England on the South African war been devoted to the development of the country, by establishing electrical railways and lighting and power plants. Even granting that pyramids and cathedrals and wars have been legitimate factors in the world's history, and that on the whole they have been beneficial, nevertheless they indicate how vast are the forces which have directly retarded rather than advanced material prosperity. There is no doubt but that the forces at hand are ample to maintain a constantly increasing condition of prosperity if they be wisely directed. A great responsibility rests upon the intellectual classes.

As a factor in maintaining prosperity, the work of the electrical engineer is of great consequence. Applied electricity so increases the efficiency of industrial and commercial life that better results and higher efficiency can be secured with a given expenditure of energy. The electrical engineer is called upon to advise and direct in many large undertakings, and upon the soundness of his judgment depends success or failure. Electricity occupies a vital place in the affairs of the present, it will be an increasing element in the future.

*Presidential address delivered at the 168th Meeting of the American Institute of Electrical Engineers, New York, September 26th, 1902.

and the electrical engineer will be an important agent in avoiding depression and maintaining prosperity.

We have considered in a somewhat general way the electrical engineer, and the engineering profession. In a profession where there are so many workers, where the majority of them are young men, where their work is so closely connected with scientific investigation and with what is being done in allied professions, when the rate of advance is so great in scientific discovery, in invention, in application to processes which are new, and in undertakings of increasing value, and particularly in a country which is recognized as foremost in electrical development, there is a unique field for a national organization such as the American Institute of Electrical Engineers.

Electrical interests are so diversified and so extended that electrical workers should be brought together. They should have a common meeting place. Here discoveries may be announced, inventions described, engineering schemes criticized and new undertakings presented and discussed. Here the student and professor, the investigator, the inventor, the manufacturer, the operator and the consulting engineer may meet upon common ground. The engineer who is tempted to ridicule scientific work finds that it is the foundation upon which his own work rests. The professor who regards slightly the work of the designing or constructing engineer may find that his own cherished formulæ are derived from the rules and contain the constants which the practical man has determined for himself. Association leads to mutual understanding, it curbs eccentricity and one-sided development, and promotes symmetrical advancement.

It is the function of the American Institute of Electrical Engineers to bring individual workers into a common unity, to join them in a community of interest, which is called the electrical engineering profession. It should place the profession of electrical engineering above suspicion of corruption and chicanery, and should call for high standards of dignity and honorable accomplishment. It should counteract the spirit of blind partisanship and of depreciation of others' efforts among those who are divided by commercial interests, whether they represent competitors or buyer and seller. While each has his individual interests, there is a general interest which is common to all. All share in that which discredits the profession as well as in that which elevates and advances it.

It is the function of the Institute to continually bring together the diversified achievements of many workers, which, taken altogether, constitute a single total of accomplishment, which is called progress. It should discriminate between that which is substantial and that which is not. It should place the stamp of recognition and approval upon all that is meritorious and marks an advance in the art.

It is the function of the Institute to take the lead in such measures as will promote the general interest of the profession and the efficiency of electrical work.

The American Institute of Electrical Engineers has represented the profession in various ways:

It has taken a prominent part in establishing uniform insurance rules in a National Code.

It has been conspicuous in representing American engineers at international expositions and international congresses, both in America and abroad. In the same connection it has been active in establishing international standards, and through its advocacy the name Henry, in honor of an American electrician, has secured a place in the list of electrical units.

It prepared, in 1890, the standard wiring table for lighting and power purposes, which has been of great service in standardizing electrical calculations.

It has established a code of standardization covering names, definitions, methods of rating, tests and the like, which is of the greatest service in unifying and simplifying electrical practice.

It has established through the generosity of a few individuals a library which in historic value is unequaled.

Let us now turn our attention to the future and consider the specific ways in which the works of the Institute may be advanced during the coming year:

1. The membership should be increased. The power and influence of the Institute is dependent upon the number, character and activity of its members. There are many engineers eligible to membership who are not members, because they do not fully appreciate the scope and the work of the Institute. There are many electrical workers who would become worthy associate members if they realized the value of connection with the Institute.

Is it not the privilege and the duty of an electrical engineer to give his best support to the Institute which stands for the highest interests of his profession? Are not the advantages which membership in the Institute affords such that no progressive engineer can afford to be without them? If these things are so, then it rests upon the present members to build up the Institute by making its work known to those who should become members.

During the past year the membership has increased 25 per cent., and reached 1,546. This is less than one-half the membership in the British Institution of Electrical Engineers. If American Institute membership bore the same relation to the kilowatt capacity of the electrical power stations of the country as does that of the British Institution, our membership should be 25,000.

There are to-day cities in which are located engineering schools and large electrical interests, which have but three or four members. Five States east of the Mississippi River have but one or two members each, and there are three of the New England States that have but three members each.

2. Papers and discussions should be contributed from a larger proportion of the membership. The transactions of the Institute should be a record of the advance in electrical work, and should contain only that which is of material value to the advancement of the art. I submit that even their present high standard does not adequately represent American electrical progress. If it is true that our papers do not fully present the advance thought and best achievements of the time, it is simply because our advance workers do not contribute more.

Material may be presented in formal papers, in original communications or in discussion. Some subjects do not provoke general discussion; others depend for their value upon the experience or the opinions of a large number of members. While the Institute is not as a body responsible for the statements or the opinions of its members, there is nevertheless an obligation resting upon its members not to leave unchallenged inaccurate and misleading statements.

Our last volume shows that 5 per cent. of the membership took part in the meetings, and that 2 per cent. furnished papers. Of these papers 10 per cent. came from miscellaneous sources, 20 per cent. came from college professors, 25 per cent. from operating and consulting engineers, and 45 per cent. from engineers connected with manufacturing companies.

These figures indicate that electrical matters are advancing so fast that even the teachers in the great technical schools fall behind the pace, because the problems come first to the manufacturer. To the manufacturing companies must be given credit for substantially advancing scientific investigation as well as practical development.

Further examination of the last annual volume shows that although one-fourth of the members reside in New York, and the monthly meetings are held there, yet only one-fifth of the papers were presented by New York members. The Institute is national in its scope, and there should be united effort throughout the entire membership to increase the quantity as well as the quality and the usefulness of its published proceedings.

3. Local meetings of the Institute in various cities will broaden the interest in its work and generally extend its benefits. Some local organizations have been formed, but this department of our work should be greatly extended. While such organizations should be conducted in harmony with the general methods and purposes of the Institute, synchronizing as far as practicable with its general meetings, they should also become "self-exciting" centers of local electrical activity. There is so much material available and there are so many subjects of local and general interest that a small amount of well-directed effort in organization will produce great results.

4. Universities and technical schools with electrical engineering departments may organize local meetings of the Institute, which would be of benefit to both instructors and students in keeping them in touch with the most recent developments and practice in electrical work. Meetings may be under the direction of the professor of electrical engineering and may be conducted in various ways to conform best to the local conditions. Local Institute members may join with the school meetings. A school should be the natural center for engineers of its vicinity. It supplies a suitable meeting place, and the discussion of Institute papers by engineers, instructors and student should be of benefit to all.

In the thesis work of students the Institute may be helpful in recognizing and publishing in abstract or in full, theses which are noteworthy. This would give an impetus to the preparation of theses and

wholesome rivalry among different institutions, and would add to the value of our transactions.

The proper education of the engineer is a problem to which various solutions are offered. All, however, will doubtless agree that the profession has already reached a stage and is advancing so rapidly that the purely "practical man" cannot hope to maintain himself in the front rank. The rate at which development is progressing demands a thorough grounding in fundamental principles, in order to impart the power for grasping and meeting new conditions.

My predecessor spoke truly when he said that the educational institutions should give the young men "a thorough understanding of the fundamental principles of electrical engineering and allied sciences, and a good knowledge of the methods of dealing with engineering problems."

The best education is that in which theoretical training in fundamental principles predominates. The true function of practical work in a broad engineering education is not to produce skilled workmen or full-fledged engineers, but it is to supplement theoretical work, making it definite and certain, so that the student may properly assimilate the instruction which he receives. Again, a student should not make his mind a storehouse of facts, but he should learn where facts and information can be gotten, and how to use them. The principal purpose for bringing the work of the Institute directly to the student and putting him in touch with practical work, is that it will assist him greatly in keeping in touch with actual things and in giving him a definite idea of the kinds of work which lie before him, and for which he is preparing.

Fortunate will it be if we can lead him to see that in the training of an electrical engineer there should be something besides technical books—that logical thinking and clear expression and general culture are indispensable in a profession that comes in touch with so many departments of science and engineering as well as industrial and commercial and social activity, and that he must be a broad man with a broad educational foundation, who would aspire to the fullest usefulness and success.

5. The collection of engineering data and the establishing of standard practice in electrical engineering is one of the important functions of the Institute. The present years are formative years. Electrical engineering is crystallizing. Electrical theory and laws and electrical measurements are more definite than those relating to the allied professions; for example, consider the relative accuracy in the predetermination of the efficiency of a dynamo with that of an engine, or the ease and precision of measurement of dynamo output by a wattmeter with that of an engine by a mechanical dynamometer or brake. Electrical engineering practice, however, is now being established. The apparatus and the methods, both in detail and in general, which characterize present work are radically different from those of five or ten years ago. It is of the highest importance to the profession that definitions and principles and laws pertaining to engineering practice should be determined and adopted as rapidly as circumstances will permit. General investigations should be made in various lines of electrical engineering work, not primarily for the purpose of devising theoretical standards or undertaking original investigations, but for the purpose of determining what is best in present practice, and of formulating and crystallizing it into what may be recognized as standard practice.

We must not fail to realize the value of standards. An English engineer in a distant part of the British Empire in specifying the apparatus for a large electrical railway, strongly recommended that American standard apparatus be purchased as "England has no standard." In Europe to-day there is a confusion of systems and frequencies and voltages, and a wide diversity in types of construction. Many foreign engineers pride themselves on devising that which is novel, instead of adapting that which is standard. American engineers are not divided by nationality and by language as are those of Europe; they have that unity in which there is strength; they appreciate the advantage of adhering to standard practice; they realize that the manufacture of dynamos and motors, as well as shoes and clocks, engines and bridges will be cheaper and quicker if made in quantity.

Do you realize the relative magnitude of American electrical work? The United States with only one-fifth the population of Great Britain and Europe has two and one-third times the kilowatt capacity in power stations and electric railways, and three and one-half times the mileage of electric railways. The power houses in operation and under contract in New York City would replace all the central stations for lighting and power in Great Britain or in Germany; they would operate all the electric railways of Great Britain and Europe combined; one alone would be sufficient for the railways of Germany, and the output of a single generator would run all the railways of Switzerland. American designs, methods and practice are being introduced into half a dozen factories in foreign countries. Electrical progress and leadership can be promoted by this Institute, as it draws together and unites the efforts of electrical workers and as it aids in establishing the standards of the future.

6. Our library merits a cordial support. Through good fortune and the generous assistance of Dr. S. S. Wheeler we have the Latimer Clark library as a foundation. Mr. Carnegie's kindly contribution has enabled the library to be catalogued and otherwise made useful Various members, notably Messrs. Mailloux, Hutchinson, Wetzler, Arnold, Keith, Caldwell, Jenks, Fish and Clarke, as well as the American Bell Telephone Company, the New York Electrical Society, and others, have contributed valuable sets of books, such as the proceedings of scientific societies, the records in patent litigation and the like. At least one member has provided by his will that a part of his technical library shall pass to the Institute, and another is proposing an endowment for the future continuation of the sets which he has presented. The policy decided upon by the library committee is to place upon our shelves every book relating to electricity in the English language, and every book of any value in the French, German and other languages. The 7,000 volumes, mostly of rare books, which we now have is a magnificent beginning. Let all who are able cooperate in this important work of building up a complete reference library.

7. Permanent quarters for the Institute should be an object of plans and anticipations. An organization which is so closely connected with so many vital interests of such vast commercial value, and which possesses such possibilities for promoting the best interests of the profession should not be hampered for want of the most convenient accommodations. Personal acquaintance and social intercourse are influential factors in unity of sentiment and of action. Our library is all but inaccessible in its present cramped quarters, which do not permit normal growth.

8. Co-operation with similar institutions in other countries will be mutually beneficial in various ways. In certain lines they may learn from us, but there is a great deal that we can learn from them.

In addition to general co-operation, such as is promoted by international congresses, much is to be gained in less formal ways. For example, different institutions may at times discuss the same subject. Again, they may do a great service to electrical progress by harmonious working in the adoption of standards. The members of one institution may broaden their outlook by becoming members of other bodies. It is the hope and expectation of our Institution to have as its guest, within the next few years, the Institution of Electrical Engineers of Great Britain. The scope of our profession is world-wide. Let us welcome this coming opportunity to extend our acquaintance and broaden our ideas.

In conclusion, I have realized the responsibilities which rest upon the president of this Institution, and it was with reluctance and misgiving that I yielded to some urgent friends and consented to become a candidate. I fully appreciate the confidence you have expressed by your votes, and I now ask your co-operation in continuing the high standard of work attained during the past year under my honored predecessor.

If, my fellow-members, the objects I have outlined are worth while, each of us can well afford to do his share towards realizing them.

Submarine Cable Laying Perils.

The cable steamer "Newington" secured the St. Lucia end of the St. Vincent cable on September 21, four and a half miles from the Soufrière volcano, on the island of St. Vincent, and had just finished buoying it, when there was a violent eruption of the volcano without the slightest warning. The steamer thereupon headed away from the land, followed by dense clouds of smoke. She had a narrow escape, and it is considered inadvisable for her to engage in further operations there, especially as the cable was found to be greatly mangled. The "Newington" will proceed to St. Thomas for a cable to complete the repair of the St. Lucia-Grenada section.

Single Phase Electric Railway System.*

By B. G. Lamme.

THE Washington, Baltimore and Annapolis Railway is a new, high-speed electric line extending from the suburbs of Washington to Baltimore, a distance of about 31 miles, with a branch from Annapolis Junction to Annapolis, a distance of about 15 miles. The overhead trolley will be used, and schedule speeds of over 40 miles per hour are to be attained. This road is to be the scene of the first commercial operation of an entirely new system of electric traction.

The special feature of this system is the use of single-phase alternating current in generators, transmission lines, trolley car equipment and motors. It constitutes a wide departure from present types of railway apparatus, and while retaining the best characteristics of the present standard direct-current motor system, the use of alternating current makes it possible to avoid many of the bad features. The standard direct-current railway equipment possesses several characteristics which fit it especially for railway service. These characteristics have been of sufficient importance to overbalance many defects in the system. In fact, a far greater amount of effort and engineering skill has been required for overcoming or neutralizing the defects, than for developing the good features possessed by the system. By far the most important characteristic possessed by the direct-current system is found in the type of motor used on the car. The direct-current railway motor is in all cases a series-wound machine. The series motor is normally a variable field machine, and it is this feature which has adapted the motor especially to railway service. Shunt-wound motors have been tried and abandoned. All manner of combinations of shunt, series and separate excitation have been devised and found wanting, and in many cases the real cause of failure was not recognized by those responsible for the various combinations. They all missed to a greater or less extent the variable-field feature of the straight series motor. It is true that a variable field can be obtained with shunt or separate excitation, but not without controlling or regulating devices, and the variation is not inherently automatic, as in the series motor. Polyphase and single-phase induction motors do not possess the variable field feature at all, as they are essentially constant-field machines. They are equivalent to direct-current shunt or separately excited motors, with constant field strength, which have been unable to compete successfully with the series motor. The variable field of the series motor makes it automatically adjustable for load and speed conditions. It also enables the series motor to develop large torques without proportionately increased currents. The automatically varying field is accompanied by corresponding variations in the counter e. m. f. of the armature, until the speed can adjust itself to the new field conditions. This feature is of great assistance in reducing current fluctuations, with a small number of steps in the regulating rheostat. Any increase in current, as resistance is cut out, is accompanied by a momentary increase in the counter e. m. f., thus limiting the current increase to a less value than in the case of constant field motor.

Next to the type of motor, the greatest advantage possessed by the direct-current system lies in the use of a single current or circuit, thus permiting the use of one trolley wire. The advantages of the single trolley are so well known that it is unnecessary to discuss them. For third rail construction, the use of single current is of even greater importance than in the case of overhead trolley. It is seen, therefore, that it is not to the direct current that credit should be given for the great success of the present railway system, but to the series type of motor and the fact that up to the present time no suitable single-phase alternating-current motor has been presented.

Some of the undesirable features of the direct-current railway system should also be considered. The speed control is inefficient. A nominally constant voltage is supplied to the car, and speed control is obtained by applying variable voltage at the motor terminals. This variation is produced by the use of resistance in series with the motors, with a loss proportional to the voltage taken up by the resistance. By means of the series-parallel arrangement, the equivlent of two voltages is obtainable at the motor terminals without the use of resistance. Therefore, with series-parallel control, there are two efficient speeds with any given torque, and with multiple control there is but one efficient speed with a given torque. All other speeds are obtained through rheostatic loss, and the greater the reduction from either of the two speeds, series or parallel, the lower will be the efficiency of the equipment. At start, the rheostatic losses are always relatively large, as practically all the voltage of the line is taken up in the rheostat. For heavy railroad service, where operation for long periods at other than full and half speeds may be necessary, the rheostatic loss will be a very serious matter.

The controlling devices themselves are also a source of trouble. An extraordinary amount of time and skill has been expended on the perfection of this apparatus. The difficulties increase with the power to be handled. The controller is a part of the equipment which is subjected to much more than ordinary mechanical wear and tear, and it can go wrong at any one of many points. The larger the equipment to be controlled, the more places are to be found in the controller which can give trouble. The best that can be said of the railway controller is that it is a necessary evil.

Another limitation of the direct-current system is the trolley voltage. Five hundred volts is common at the car and 650 volts is very unusual. By far the larger number of the railway equipments in service to-day are unsuited for operation at 600 volts, and 700 volts in normal operation would be unsafe for practically all. The maximum permissible trolley voltage is dependent upon inherent limitations in the design of motors and controllers. The disadvantages of low voltage appear in the extra cost of copper and in the difficulty of collecting current. In heavy railroad work, the current to be handled becomes enormous at usual voltages. A 2,400-hp electric locomotive, for example, will require between 3,000 and 4,000 amperes at normal rated power, and probably 6,000 to 8,000 amperes at times. With the overhead trolley these currents are too heavy to be collected in the ordinary manner, and it is a serious problem with any form of trolley or third-rail system which can be used. It is evident that for heavy service, comparable with that of large steam railways, a much higher voltage than used in our present direct-current system is essential, and the use of higher voltage is destined to come, provided it is not attended by complications which more than overbalance the benefits obtained. A further disadvantage of the direct-current system is the destructive action known as electrolysis. This may not be of great importance in interurban lines, chiefly because there is nothing to be injured by it. In city work its dangers are well-known, and very expensive constructions are now used to eliminate or minimize its effects.

From the above statements it is evident that an alternating-current railway system, to equal the direct-current should possess the two pripcipal features of the direct-current system, viz.: A single supply circuit and the variable field motor, and to be an improvement upon the direct-current system, the alternating current should avoid some of the more important disadvantages incident to the present direct-current railway apparatus.

The system must, therefore, be single-phase. The importance of using single-phase for railway work is well known. The difficulties and complications of the trolley construction are such that several alternating-current systems have been planned on the basis of single-phase supplied to the car, with converting apparatus on the car to transform to direct current, in order that the standard type of railway motors may be used. Such plans are attempts to obtain the two most valuable features of the present direct-current system. The polyphase railway system, used on a few European roads, employs three currents, and, therefore, does not meet the above requirement. The motor for the alternating-current railway service should have the variable speed characteristics of the series direct-current motor. The polyphase motor is not suitable, as it is essentially a constant-field machine, and does not possess any true variable speed characteristics. Therefore, it lacks both of the good features of the direct-current railway system. A new type of motor must, therefore, be furnished, as none of the alternating-current motors in commercial use are adapted for the speed and torque requirements of first-class railway service. Assuming that such a motor is obtainable for operation on a single-phase circuit, the next step to consider is whether the use of alternating instead of direct current on the car will allow some of the disadvantageous features of the direct-current system to be avoided. The direct-current limits of voltage are at once removed, as transformers can be used for changing from any desired trolley voltage to any convenient motor voltage. Electrolysis troubles practically disappear. As transformers can be used, variations in supply voltage are easily obtainable. As the motor is as-

* A paper presented at the September Meeting of the American Institute of Electrical Engineers.

sumed to have the characteristics of the direct-current series motor, speed control without rheostatic loss is practicable when voltage control is obtained. This combination, therefore, allows the motor to operate at relatively good efficiency at any speed within the range of voltage obtained. If the voltage be varied over a sufficiently wide range, the speed range may be carried from the maximum desired down to zero, and, therefore, down to starting conditions. With such an arrangement no rheostat need be used under any conditions, and the lower the speed at which the motor is operated, the less the power required from the line. The least power is required at start, as the motor is doing no work and there is no rheostatic loss. The losses at start are only these in the motor and transforming apparatus, which are less than when running at full speed with an equal torque. Such a system, therefore, permits maximum economy in power consumed by motor and control. This economy in control is not possible with the polyphase railway motor, as this motor is the equivalent of the direct-current shunt motor, with which the rheostatic loss is even greater than with the series motor.

The use of alternating current on the car allows voltage control to be obtained in several ways. In one method a transformer is wound with a large number of leads carried to a dial or controller drum. The Stillwell regulator is a well-known example of this type of voltage control. This method of regulation is suitable for small equipments with moderate currents to be handled. The controller will be subject to some sparking, as in the case of direct-current apparatus, and, therefore, becomes less satisfactory as the car equipment is increased in capacity. Another method of control available with alternating current is entirely non-sparking, there being no make-and-break contacts. This controller is the so-called "induction regulator," which is a transformer with the primary and secondary windings on separate cores. The voltage in the second ary winding is varied by shifting its angular position in relation to the primary. With this type of voltage controller, very large currents can be handled, and it is especially suitable for heavy equipments, such as locomotives. It is thus seen that there is one method of control available with alternating current, which avoids the troubles inherent to the direct-current controller. The induction regulator is primarily a transformer, and all wear and tear is confined to the supports which carry the rotor. Therefore, the objectionable controller of the standard direct-current system can be eliminated, provided a suitable alternating-current motor can be obtained. This ideal type of controller is not applicable to the polyphase railway motor, in which speed control can be obtained only through rheostatic loss. The polyphase control system is even more complicated than the direct current, as there must be a rheostat for each motor, and two or three circuits in each rheostat. It is thus apparent that by the use of single-phase alternating current with an alternating-current motor having the characteristics of the direct-current series motor, the best features of the direct-current system can be obtained, and at the same time many of its disadvantages can be avoided.

This portion of the problem, therefore, resolves itself into the construction of a single-phase motor having the characteristics of the direct-current series motor. There are several types of single-phase, alternating-current motors which have the series characteristics. One type is similar in general construction to a direct-current motor, but with its magnetic circuit laminated throughout, and with such proportions that it can successfully commutate alternating current. Such a motor is a plain series motor, and can be operated on either alternating or direct current, and will have the same torque characteristics in either case. Another type of motor is similar in general construction to the above, but the circuits are arranged in a different manner. The field is connected directly across the supply circuit with proper control appliances in series with it. The armature is short-circuited on itself across the brushes, and the brushes are set at an angle of approximately 45 degrees from the ordinary neutral point. The first of these two types of motors is the one best adapted for operation in large units.

This is the type of motor which is to be used on the Washington, Baltimore and Annapolis Railway. Several motors have been built and tested with very satisfactory results, both on the testing stand and under a car. The results were so favorable that the system was proposed to the Cleveland Engineering Company, representing the Washington, Baltimore and Annapolis Railway, and after investigation by their engineers, the system was adopted. A description of the apparatus to be used on this road will illustrate the system to good advantage.

Single-phase alternating current will be supplied to the car at a frequency of 16⅔ cycles per second, or 2,000 alternations per minute. The current from the overhead trolley wire is normally fed in by one trolley at approximately 1,000 volts. Within the limits of the District of Columbia two trolleys are employed, as by Act of Congress the use of rails as conductors is prohibited in this District, presumably on account of electrolysis. In this case the trouble, of course, will not exist, but the contracting company has been unable to obtain permission for the grounded circuit.

The alternating current to the car is carried through a main switch or circuit breaker on the car, to an auto-transformer connected between the trolley and the return circuit. At approximately 300 volts from the ground terminal, a lead is brought out from the auto-transformer and passes through the regulator to one terminal of the motors. For starting and controlling the speed, an induction regulator is used with its secondary winding in series with the motor. This secondary circuit of the regulator can be made either to add to, or substract from the transformer voltage, thus raising or lowering the voltage supplied to the motors. The regulator, therefore, does double duty. The controller for direct-current motors merely lowers the voltage supplied to the motors but cannot raise it, but an alternating-current regulator can be connected for an intermediate voltage, and can either raise or lower the motor voltage. In this way the regulator can be made relatively small, as it handles only the variable element of the voltage and the maximum voltage in the secondary winding is but half of the total variation required.

In the equipments in question, the range of voltage at the motor is to be varied from approximately 200 volts up to 400 volts or slightly higher. The transformer on the car will supply 315 volts, and the secondary circuit of the regulator will be wound to generate slightly more than 100 volts when turned to the position of its maximum voltage. This voltage of the regulator is about one-fourth of that of the motors at full voltage. The regulator can consequently be made relatively small, in comparison with the motor capacity of the equipment. It has been found unnecessary to use much lower than 200 volts in this installation, as this voltage allows a comparatively low running speed, and approximately 200 volts will be necessary to start with the required torque. The greater part of this voltage is required to overcome the e. m. f. of self-induction in the motor windings, which is dependent upon the current through the motor and is independent of the speed of the armature.

There will be four motors of 100 hp on each car. The full rated voltage of each motor is approximately 220 volts. The motors are arranged in two pairs, each consisting of two armatures in series, and two fields in series, and the two pairs are connected in parallel. The motors are connected permanently in this manner. As voltage control is used, there is no necessity for series parallel operation, as with direct-current motors. To ensure equal voltage to the armatures in series, a balancing or equalizing action is obtained by the use of a small auto-transformer connected permanently across the two armatures in series with its middle point connected between them. The fields are arranged in two pairs, with two fields in series and two pairs in multiple. This parallels the fields independently of the armatures, which was formerly the practice with direct-current motors. It was a defective arrangement with such motors, as equal currents in the field did not ensure equal field strengths in the motors, and the armatures connected in parallel would be operating in fields of unequal strength, with unequal armature currents as a direct result. With alternating currents in the fields, the case is different. The voltage across the fields is dependent upon the field strengths, and the current supplied to the fields naturally divides itself for equal magnetic strengths. The chief advantage in paralleling the fields and armatures independently is, that one reversing switch may serve for the four motors and one balancing transformer may be used across the two pairs of armatures. The usual direct-current arrangement of armatures in series with their own fields can be used, with a greater number of switches and connections.

The general arrangement of the auto-transformer, regulator, motors, etc., is shown in Fig. 1.

The induction regulator or controller, resembles an induction motor in general appearance and construction. The primary winding is placed on the rotor, and the secondary or low voltage winding on the stator. The rotor also has a second winding which is permanently short-circuited on itself. This function of this short-circuited winding is to neutralize the self-induction of the secondary winding as it passes from the magnetic influence of the primary. The regulator is wound for two poles, and, therefore, is operated

through 180 degrees for producing the full range of variation of voltage for the motors. One end of the primary winding of the regulator is connected to the trolley, and the other to a point between the regulator and the motors. It thus receives a variable voltage as the controller is rotated. There are several advantages in this arrangement of the primary in this particular case. First, the regulator is worked at a higher induction at start, and at lower induction when running, the running position being used in these equipments for much longer periods than required for starting. Second, when

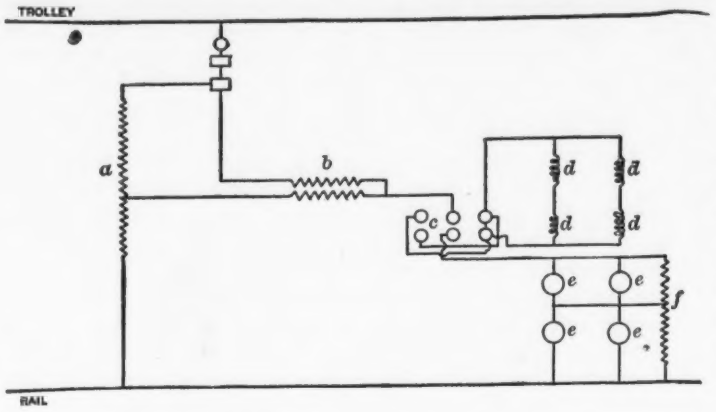


FIG. 1.—*a*. AUTO-TRANSFORMER. *b*. INDUCTION REGULATOR. *c*. REVERSING SWITCH. *d*. FIELD OF MOTORS. *e*. ARMATURE OF MOTORS. *f*. EQUALIZING TRANSFORMER.

the motors are operating at full voltage the current in the primary of the regulator passes through the motors but not through the auto-transformer or the secondary of the regulator. This allows considerable reduction in the size of auto-transformer and regulator. The motors on the car are all of the straight series type. The armature and fields being connected in series, the entire current of the field passes through the armature as in ordinary series direct-current motors. The motor has eight poles, and the speed is approximately 700 revolutions at 220 volts. The general construction is similar to that of a direct-current motor, but the field core is laminated throughout, this being necessary on account of the alternating magnetic field. There are eight field-coils wound with copper strap, and all connected permanently in parallel. The parallel arrangement of field-coils assists in the equalizing of the field strength in the different poles, due to the balancing action of alternating circuits in parallel. This arrangement is not really necessary, but it possesses some advantages and, therefore, has been used. With equal magnetic strength in the poles, the magnetic pull is equalized even with the armature out of center. The armature is similar in general construction to that of a direct-current motor. The fundamental difficulty in the operation of a commutator type of motor, on single-phase alternating current lies in the sparking at the brushes. The working current passing through the motor should be practically no more difficult to communicate than an equal direct current, and it is not this current which gives trouble. The real source of trouble is found in a local or secondary current set up in any coil, the two ends of which are momentarily short-circuited by a brush. This coil encloses the alternating magnetic field, and thus becomes a secondary circuit of which the field-coil forms the primary. In the motors of the Washington, Baltimore and Annapolis Railway, this commutation difficulty has been overcome by so constructing the motor that the secondary or short-circuit current in the armature coil is small, and the commutating conditions so perfect that the combined working and secondary currents can be commutated without sparking. This condition being obtained, the motor operates like a direct-current machine and will give no more trouble at the commutator than ordinary direct-current railway motors. Experience covering a considerable period in the operation of motors of 100-hp capacity indicates that no trouble need be feared at the commutator.

An extended series of tests were made at the Westinghouse shops, at East Pittsburg, both in the testing room and under a car. Fig. 2 shows curves of the speed, torque, efficiency and power factor plotted from data from brake tests.

It should be noted that the efficiency is good, being very nearly equal to that of high-class direct-current motors. The power factor, as shown in these curves, is highest at light loads and decreases with the load. This is due to the fact that the power developed increases approximately in proportion to the current, while the wattless component of the input increases practically at the square of the current. The curve indicates that the average power factor should be very good. The calculations for the W. B. and A. Railway show that the average power factor of the motors will be approximately 96 per cent.

The average efficiency of these equipments will be much higher during starting and acceleration than that of corresponding direct-current equipments, and rheostatic losses are avoided. When running at normal full speed, however, the efficiency will be slightly less than with direct current. This is due to the fact that the alternating-current motor efficiency is slightly lower than the direct-current, and in addition there are small losses in the transformer and the regulator. The alternating-current equipments are somewhat heavier than the direct-current, thus requiring some extra power, both in accelerating and at full speed. Therefore, for infrequent stops the direct-current car equipment is more efficient than the alternating-current, but for frequent stops the alternating current shows the better efficiency. Tests on the East Pittsburg track verified this conclusion. But the better efficiency of the direct-current equipment with infrequent stops is offset with the alternating current by decreased loss in the trolley wire, by reason of the higher voltage used, and the elimination of the rotary converter losses. The resultant efficiency for the system will, therefore, be equal to or better than that of the direct current.

In the W. B. and A. Railway contracts the guarantee given by the Westinghouse Electric and Manufacturing Company states that the efficiency of the system shall be equal to that of the direct-current system with rotary converter substations.

There is one loss in the alternating-current system which is relatively much higher than in the direct-current. This is the loss in the rail return. Tests have shown that at 2,000 alternations this is three to four times as great as with an equal direct current. This would be a serious matter in cases where the direct-current rail loss is high. But the higher alternating-current trolley voltage reduces the current so much, that the alternating-current rail loss is practically the same as with direct current at usual voltages. In many city railways the direct-current rail loss is made very low, not to

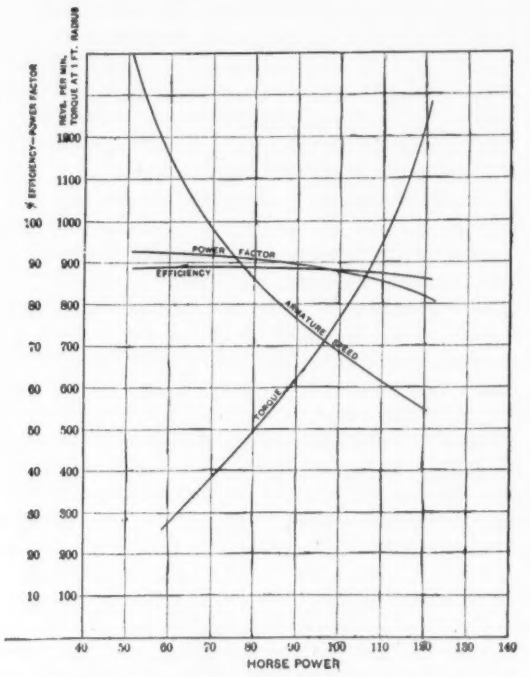


FIG. 2.—CURVES OF SPEED, TORQUE AND POWER FACTOR.

lessen waste of power, but in order to reduce electrolysis. In such cases the alternating-current rail loss could be higher than direct current, thus decreasing the cost of return conductors. More frequent transformer substations, with copper feeders connected to the rails at frequent intervals will enable the rail loss to be reduced to any extent desired. As a frequency of 2,000 alternations per minute is used, the lighting of the cars and the substations was at first considered to be a serious difficulty, due to the very disagreeable winking of the ordinary incandescent lamps at this frequency. Two methods of overcoming the winking were tried, both of which were successful. One method was by the use of split phase. A two-phase

induction motor was run on a single-phase, 2,000 alternating circuit, and current was taken from the unconnected primary circuit of the motor. This current was, of course, at approximately 90 degrees from the current of the supply circuit. A two-phase circuit was thus obtained on the car. Currents from the two phases were put through ordinary incandescent lamps, placed close together. The resulting illumination a few feet distant from the lamps showed about the same winking as is noticed with 3,000 alternations. With two filaments in one lamp the winking disappears entirely. A three-phase arrangement would work in the same way.

A much simpler method was tried, which worked equally well. This consisted in the use of very low-voltage lamps. Low voltage at the lamp terminals allows the use of a thick filament with considerable heat inertia. Tests were made on lamps of this type at a frequency of 2,000 alternations, and the light appeared to be as steady as that from the ordinary high-frequency incandescent lamp. The low voltage is not objectionable in this case, as a number of lamps can be run in a series, as in ordinary street railway practice, and any voltage desired can readily be obtained, as alternating current is used on the car.

There will be an air compressor, driven by a series alternating-current motor, on each car, for supplying air to the brakes and for operating the driving mechanism of the controller. The details of this mechanism are not near enough to completion to permit a description of it. The method used will be one which readily allows operation on the multiple-unit system.

The generating station contains some interesting electrical features, but there is no great departure from usual alternating-current practice. There will be three 1,500-kw, single-phase alternators. These are 24-pole machines, operating at 83 revolutions, and wound for 15,000 volts at the terminals. They are of the rotating-field type, with laminated magnetic circuits and field-coils of strap on edge. The field-coils are held on the pole-tips by copper supports, which serve also as dampers to assist in the parallel running. The armatures are of the usual slotted type. The armature coils are placed in partially closed slots. There are four coils per pole. The proportions of these machines are such that good inherent regulation is obtained without saturation of the magnetic circuit. The rise in potential with non-inductive load thrown off will be approximately 4 per cent. An alternative estimate was furnished for the generators proposing 20,000 volts instead of 15,000. The simplicity of the type of winding used, and the low frequency, are both favorable for the use of very high voltage on the generator. As 15,000 volts was considered amply high for the service, the engineers for the railway considered it unadvisable to adopt a higher voltage.

There are to be two exciters, each of 100-kw capacity at 250 revolutions. The exciters are wound for 125 volts normal. The armature of each exciter has, in addition to the commutator, two collector rings, so that single-phase alternating current can be delivered. It is the intention to use the exciters as alternators for supplying current to the system for lighting when the large generators are shut down at night. The main station switchboard comprises three generator panels, one load panel, and three feeder panels. High-tension, oil-break switches are to be provided, operated by means of controlling apparatus on the panels. The switches, busbars and all high-tension apparatus will be in brick compartments separate from the board. In each generator circuit there are two non-automatic, oil-break switches in series; and on each feeder circuit there are two overload time-limit oil-break switches in series. The two oil-break switches in series on the same circuit can be closed separately and then opened to test the switches without closing the circuit. With the switches in the closed position they are both operated at the same time by the controller, to ensure opening of the circuit, and to put less strain on the switches, although either one is capable of opening the load. There will be nine transformer substations distributed along the railway line. Each station will contain two 250-kw, oil-cooled, lowering transformers, supplying approximately 1,000 volts to the trolley system. The transformers are used in each station so that in case of accident to one transformer the station will not be entirely crippled. It is the intention of the railway company to operate a direct-current road already equipped with the direct-current system. The present direct-current car equipments are to be retained, but the current will be supplied from a rotary converter substation fed from the main system of the W. B. and A. Railway. As this system is single-phase, it is necessary that single-phase rotaries be used in the substation. There are to be two kw 550-volt, rotary converters. These are 4-pole, 500-revolution machines. The general construction of these machines is very similar to that of the Westinghouse polyphase rotary converters. The armature resembles that of a polyphase rotary, except in the number of collector rings, and in certain details of the proportions made necessary by reason of the use of single-phase. The commutating proportions are so perfect that any reactions due to the use of single-phase will result in no injurious effect. The field construction is similar to that of a polyphase rotary. The laminated field-poles are provided with dampers of the "grid" or "cage" type, a form used at present in the Westinghouse polyphase rotary converters. This damper serves to prevent hunting, as in the polyphase machines, and also to damp out pulsations due to single-phase currents in the armature. The damper acts to a certain extent as a second phase. Each rotary converter is started and brought to synchronous speed by a small series alternating-current motor on the end of the shaft. The voltage at the motor terminals can be adjusted either by loops from the lowering transformer or by resistance in series with the motor, so that true synchronous speed can be given to the rotary converter, before throwing it on the alternating-current line.

From the proceeding description of this system and the apparatus used on it, some conclusions may be drawn as to the various fields where it can be applied to advantage. It is evident that a good field for it will be on interurban, long-distance lines, such as the W. B. and A. Railway. On such railways, high trolley voltage and the absence of converter substations are very important factors.

For heavy railroading also, this system possesses many ideal features. It allows efficient operation of large equipments at practically any speed and any torque, and also avoids the controller troubles which are ever present with large direct-current equipments. It also permits the use of high trolley voltage, thus reducing the current to be collected. In this class of service the advantages of this alternating-current system are so great that it is possible that heavy railroading will prove to be the special field for it.

For general city work, this system may not find a field for some time to come, as the limitations in the present system are not so great that there will be any great necessity for making a change. It is probable that at first this system will be applied to new railways, or in changing over steam roads rather than in replacing existing city equipments. One difficulty with which the new system will have to contend is due to the fact that the alternating-current equipments cannot conveniently operate on existing city lines, as is the present practice where interurban lines run into the cities. It will be preferable for the alternating-current system to have its own lines throughout, unless very considerable complication is permitted. When the alternating-current system applied to interurban and steam railway systems finally becomes of predominant importance, it is probable that the existing direct-current railways will gradually be changed to alternating current as a matter of convenience in tying the various railway systems together.

As was stated above, alternating-current equipments cannot conveniently be operated on direct-current lines. It does not follow that the motor will not operate on direct current. On the contrary, the motor is a first-class direct-current machine, and if supplied with suitable control apparatus and proper voltage it will operate very well on the direct-current lines. This would require that the motors be connected normally in series, as the voltage per motor is low. A complete set of direct-current control apparatus would be needed when the alternating-current equipment is to be run on direct current, and considerable switching apparatus would be necessary for disconnecting all the alternating-current control system and connecting in the direct current. The complication of such a system may be sufficient to prevent its use, at least for some time to come.

In some cities, very strict laws are in force in regard to the voltage variations in various parts of the track system. The permissible variations are so small in some cases that an enormous amount of copper is used for return conductors; and in some cases special boosters are used in the return circuits to avoid large differences of potential between the various parts of the track system. The object in limiting the conditions in this manner is to avoid troubles from electrolysis. The alternating-current system will, of course, remedy this.

For city work, it is probable that voltages of 500 or 600 would be employed instead of 1,000 or higher. The transformers and controllers can be designed to be readily changed from full to half voltage, so that low voltage can be used on one part of the line and high

voltage on another. As the car equipments of such railways are usually of small capacity, it is probable that speed control will be obtained by means of a transformer with a large number of leads carried out to a control drum, rather than by means of the induction regulator, as the latter device is much more expensive in small units. This is chiefly a question of cost, and if the advantages of the induction regulator are found to over-weigh the objections of high first cost, then it will be used even on small equipments.

In the W. B. and A. Railway, the generators are wound for single-phase. In the case of large power-stations with many feeders, the generators may be wound for three-phase, with single-phase circuits carried out to the transformer substation, or three-phase transmission may be used, with the transformers connected in such a manner as will give a fairly well-balanced three-phase load.

There are many arrangements and combinations of apparatus made possible by the use of alternating current in the car equipments, which have not been mentioned, as it is impracticable to give a full description of all that can be done. But enough has been presented to outline the apparatus and to indicate the possibilities of this new system which is soon to see the test of commercial service.

DISCUSSION.

The discussion of Mr. Lamme's paper was participated in by Messrs. Steinmetz, Mershon, Goldsborough, Arnold, Franklin, Roe, Mailloux, Sachs, Gotschall, Wagner and Ries. Mr. Steinmetz referred to the enthusiasm abroad with respect to polyphase traction, which he says has to a large extent affected the American technical press. He said, however, that the engineers of American electrical manufacturing companies had gone over the polyphase traction field experimentally years ago and satisfied themselves that the polyphase induction motor is no more fitted for railway work than is the direct-current shunt motor; and since then they have gone over the matter again and again, and always arrived at the same conclusions. He felt disappointed in reading the paper by learning that after all the new motor is no more than our old friend, the direct-current series motor adapted to alternating currents by laminating the field. He said that when he was connected with Mr. Eickemeyer, in 1891 and 1892, a great deal of time was spent in building such motors, investigating their behavior and trying to cure them of their inherent vicious defect of inductive sparking at the commutator. No success was achieved, however, but Mr. Steinmetz expressed the hope that Mr. Lamme would have better fortune. He considered that there is some chance for this, as in the ten years that have elapsed since the work at Yonkers, engineering has advanced a great deal, and the experiments there were conducted with higher frequencies than used by Mr. Lamme. Such a motor inherently has a very poor power factor, and to get a reasonable power factor it has to be run at a very high speed, and it, therefore, was gratifying to see that Mr. Lamme operates his 16-cycle motor at three time synchronous speed, and therefore gets a good power factor. Mr. Steinmetz said that he considered the Thomson repulsion type of motor superior to that described. In this type the armature is connected to a commutator and brushes, but the supply current does not pass through the armature, which is short-circuited upon itself through the brushes, which latter are shifted by a certain angle. The repulsion motor gives a speed and torque characteristic very closely resembling that of the direct-current series motor. In conclusion, Mr. Steinmetz said that alternating-current traction will only be feasible when the single-phase motor is developed to start with a maximum torque, the torque decreasing with increase of speed.

Mr. Mershon said that although in this case alternating-current traction has apparently been achieved by means of a single-phase motor, he has not by any means lost hope for the polyphase motor, but feels confident enough to predict that the time will come when an induction motor for variable speed will be developed having properties just as efficient as the motor described, and, perhaps, more efficient; that it will develop power at speeds below the maximum in more or less proportion to the speed, which power will not require to be graded by means of rheostats, but will be taken from the supply circuit power in an amount closely in proportion to the power the motor develops. Mr. Mershon asked Mr. Lamme to state the means for reducing the sparking and also the method of design by which the high-power factor stated is obtained. Prof. Goldsborough expressed the opinion that in a few years from now there will be a standard single-phase, alternating-current railway equipment, but that he does not think anyone knows at present what the system as eventually developed will be.

Mr. Arnold expressed his pleasure that Mr. Lamme, representing one of the large manufacturing companies, had come out in favor of single-phase traction. He took exception to the statement in the paper that the Washington-Baltimore road would be the first single-phase railway in this country. In February, 1899, he had taken a contract to built 60 miles of single-phase railroad. The line has been built, tracks laid, the trucks and cars have been finished, and as the road will soon go into operation he believes that it will be the first railway equipped with single-phase motors. He hoped to present a paper at the October or November meeting giving an engineering account in detail of the system. In conclusion, he said that if Mr. Lamme is able to make an alternating-current, single-phase commutator motor operate without sparking at the commutator, he is entitled to the greatest credit.

Mr. C. O. Mailloux in referring to the backwardness of Americans in alternating-current traction, said that this follows from the fact that the alternating-current system must undergo a great deal of development before it can hope to contend with the direct-current sysem. One of the first things is to do away with more than one trolley, and the system described by Mr. Lamme possesses this advantage. The motor proposed, however, is nothing but a series direct-current motor adapted to alternating currents, and unfortunately the paper does not tell the manner in which it is proposed to obviate the defects of such a motor. The paper does not give indication that any radically new feature is introduced. It would appear that Mr. Lamme depends more upon features of design and proportioning than upon original ideas, either in regulation or control. Mr. Wagner said that he had always been an advocate of the single-phase, alternating-current motor, and spent a great many years in developing such a motor for stationary work. He considered that there is a very promising future for the type of motor known as the Thomson repulsion motor. He has experimented with this type a great deal and knows that sparking, especially at low frequencies, can be overcome. He asked Mr. Lamme if it was not necessary in his design to have a very small air-gap in order to obtain a high-power factor; he also asked if the field of the motor is constructed with the ordinary polar projections of the direct-current motor or whether it is a slotted ring, and if the field winding is distributed or a single coil winding. Mr. Elias E. Ries referred to some work which he did in 1894 in connection with a single-phase, alternating-current railway between Baltimore and Washington. He designed a system for operating the line by means of single-phase, alternating-current motors, which he said in many respects is similar to that proposed by Mr. Lamme.

Mr. Lamme said that the apparatus described for the Baltimore-Washington road is not an experimental apparatus, but that the contract for the Washington-Baltimore has been actually taken and that the apparatus is now being built. He had considered the use of the repulsion type of motor, but came to the conclusion that it was not as good for the work as the type adopted; the construction is more complicated because reversal of the direction of rotation is not so easily accomplished as in the plain series motor, and there would be more weight. Referring to the opinion expressed that the new system practically goes back to a well-known old type of motor, he said that it accomplishes a result which has never been accomplished before, which indicates that there are some features in the apparatus which have not been utilized in former apparatus. Referring to Mr. Arnold's remarks, he said that the Washington-Baltimore road is the first single-phase road that he knew of. In reply to the requests for further information concerning his system, Mr. Lamme said that at present there are reasons why he does not care to give out further information, but when the proper times comes this will be done.

A Battleship Plant.

The new United States battleship "Connecticut" is to be lighted throughout by electricity. The electric plant on the ship will consist of eight 100-kw steam-driven generating sets, all of 125 volts at the terminals, disposed in two separate and independent dynamo rooms. Six electrically-driven generators will supply current to turret turning motors. There will be 1,100 electric fixtures, complete, with necessary incandescent lamps and outlets; ten inclosed arc lamps located in engine and fire rooms; six 30-inch searchlights mounted on platforms on bridges, with spare parts; two truck lights, with controller and stand complete; electric night signaling sets, diving lamps, ventilating sets, desk and bracket fans, etc. It is to be hoped she will also have a wireless telegraph outfit.

Apparatus of the Braun-Siemens & Halske System of Wireless Telegraphy.

THE accompanying series of cuts illustrate the electrical and mechanical equipment of the Braun-Siemens and Halske system of syntonic wireless telegraphy, the general theory and construction of which was published in the ELECTRICAL WORLD AND ENGINEER, of June 14, 1902. A complete standard station set for transmitting and receiving wireless messages, such as are now being produced by the Gesselschaft fur Drahtlose Telegraphie, of Berlin, is shown in Fig. 1, and includes all the necessary devices for selective signaling by electrical resonance using high-frequency, high-potential currents of predetermined periodicity. In Fig. 7 the instruments are shown detached, and after careful testing they are arranged in regular order prior to packing for shipment. Beginning at the left, it will be observed that the parts are numbered consecutively.

For instance 1 (Fig. 1) illustrates the transformer operating the open and closed circuit; the adjustable condensers, 2, are arranged like a test-tube stand; 4 is the inductorium or Ruhmkorff induction coil, the spark-gap of which is not shown in this figure, but on referring to Fig. 4, it will be seen standing out in relief from the adjustable condensers; the suspended metal cylinders with the bases or ends elliptical, 5 and 13, are capacity areas, employed instead of the a cylinder of glass, having ebonite ends and filled with oil (Fig. 4), thus causing the disruptive discharge to take place in a dielectric having a greater specific inductive capacity than that of free air. The spark-gap is in series with the adjustable capacities and the primary of the transformer.

As shown in Fig. 4, the capacities are arranged in two divisions, and each half is connected on either side of the spark-gap and the primary of the transformer. By removing or adding to the miniature Leyden jars, a variable capacity is obtained, by which the closed circuit oscillator is tuned not only to the period of the open circuit radiator, but to its own natural frequency of oscillation; the inductance of the closed circuit is supplied by the primary of the transformer, and the resistance may be made to conform to these coefficients by increasing or decreasing the length of the spark-gap.

The induction coil is designed especially to fulfill the heavy demands required of a commercial wireless telegraph generator. The soft iron core is large in diameter considering its length, which is a great advantage when an electrolytic interrupter is employed in connection with it, since the B H curves are described with little retardation even when the frequency of interruption reaches a value of 10,000 per minute. The secondary coil is of comparatively thick wire and doubly insulated, thus eliminating the weakest point generally found in this type of high-tension generators; and by this extra precaution to exclude air and moisture, the electrostatic bom-

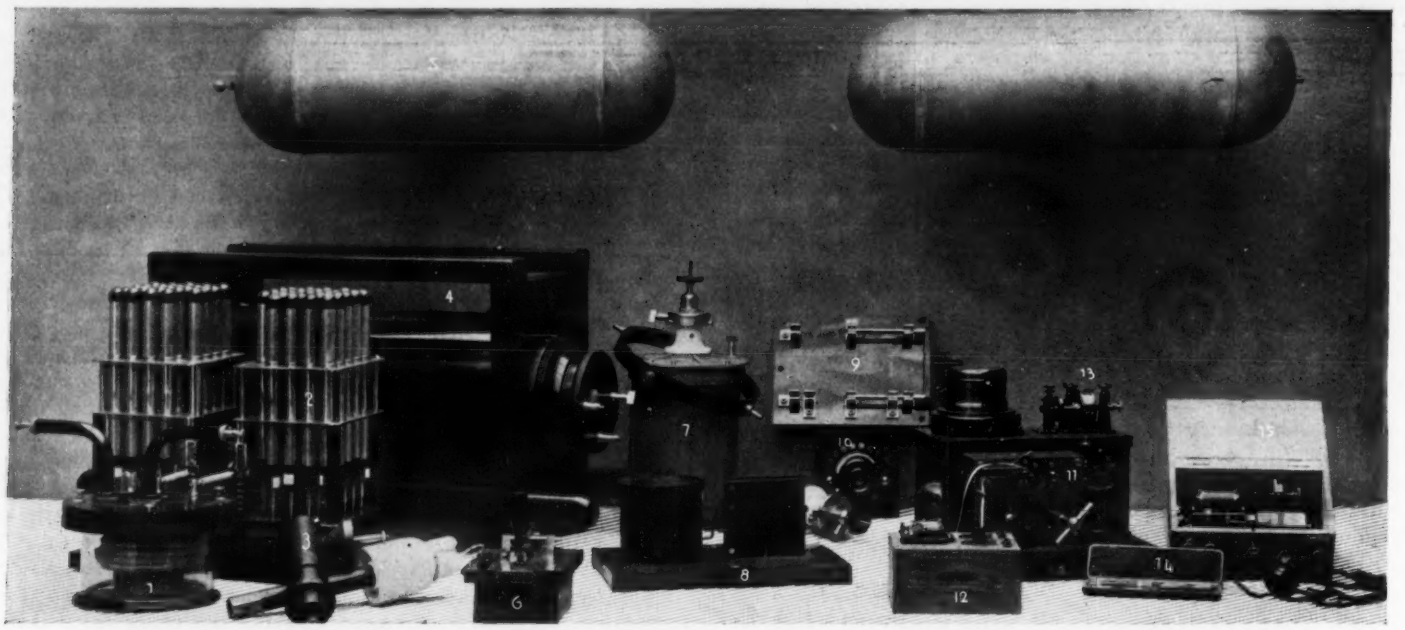


FIG. 1.—BRAUN-SIEMENS & HALSKE WIRELESS TELEGRAPH TRANSMITTING AND RECEIVING APPARATUS.

earth. The key 6 is arranged for breaking the heavy primary currents which excite the inductor of the Ruhmkorff coil, and 7 represents an electrolytic interrupter of the Wehnelt type; this with the exception of the source of current completes the transmitting apparatus. The receiving apparatus begins with 8, which is the transformer and condenser employed in the resonator open and closed circuits. The switch, 9, is employed to cut in and out the transmitting and receiving apparatus from the antennæ; the Morse register, 11, is connected with a polarized relay, which is enclosed in a cylindrical metal box to exclude all extraneous waves; the coherer and tapping device are arranged on top of the box 13, while a case of coherers is shown at 14. Usually a receiving apparatus, 15, employing a microphonic self-restoring coherer with a pair of head telephones, is included, so that in case of any untoward occurrence by which the standard recording instruments might be disabled, messages may still be received without interruption.

The high-tension transformer employed in the compound oscillator is shown in Figs. 2 and 3. It consists of an inductor having four turns of heavy wire wound outside a secondary coil formed of 30 or 40 turns of fine wire, so that the oscillations set up in the closed circuit may be stepped-up in the open circuit radiator emitting the waves. The transformer removed from the jar shows more clearly its internal construction, and is simply an air-core induction coil with the primary well insulated and its relative position to the secondary reversed; when in use, the whole is immersed in oil.

The oscillator balls forming the spark-gap are arranged within bardment caused by oscillatory currents, which result in caloric effects and the final disruption of the coil is precluded.

With the Braun induction coil and electrolytic interrupter no condenser is required, for the reason that the "break" more nearly approaches the ideal interruption of the current, *i. e.*, an absolutely instantaneous "break," than in any other form of interrupter. The key designed by Braun for arbitrarily making and breaking the heavy primary currents used in the operation of these large and powerful coils is shown in Figs. 5 and 6. In Fig. 5 the key proper is illustrated and Fig. 6 is a view of the interior showing the magnets for blowing out the spark formed on breaking the primary current between the platinum points of the key. This device is due primarily to Davy's discovery of the effect of a magnetic field upon the voltaic arc, and as a means of preventing injurious discharges it has been the subject of much litigation in the United States, in the Thomson "magnetic blow-out" suits.

The complete equipment of the Braun-Siemens and Halske system is shown in Fig. 7, set up and connected ready for operation. The connections may be followed almost as readily as in the previously published diagrams. A current from a 110-volt circuit or a storage battery—according to specifications—is led from the outside to the switchboard and thence through the plug cut-outs, ammeter, voltmeter, small switch and electrolytic interrupter to the primary winding or inductor of the coil on the floor. From the secondary terminals of the induction coil, conductors lead to the spark-gap, condensers and primary of the transformer. From the secondary of the

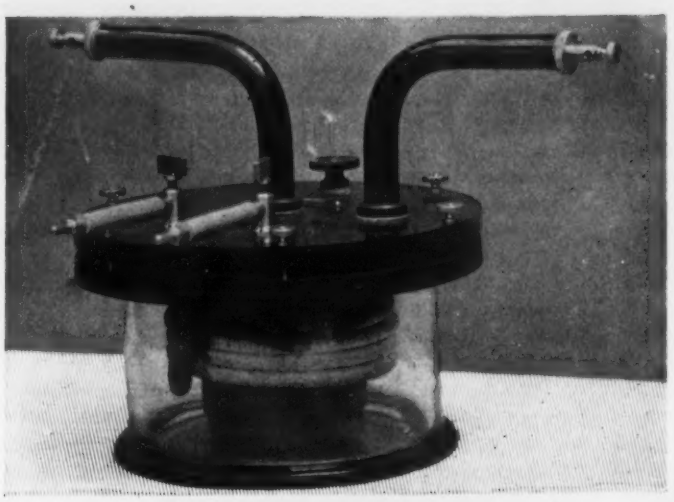


FIG. 2.—TRANSFORMER FOR WIRELESS TELEGRAPHY.

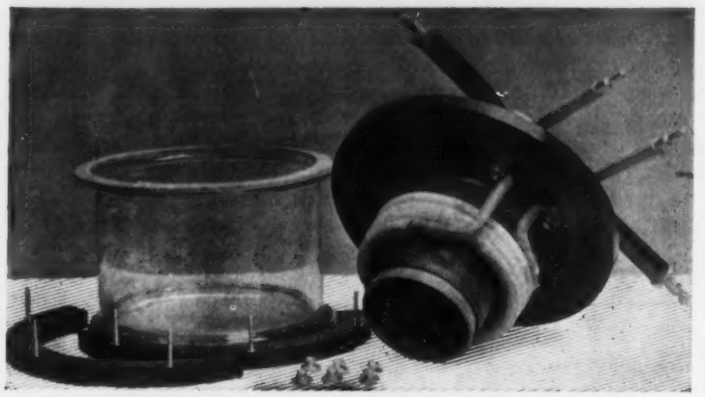


FIG. 3.—HEAVY-CURRFNT TRANSFORMER.

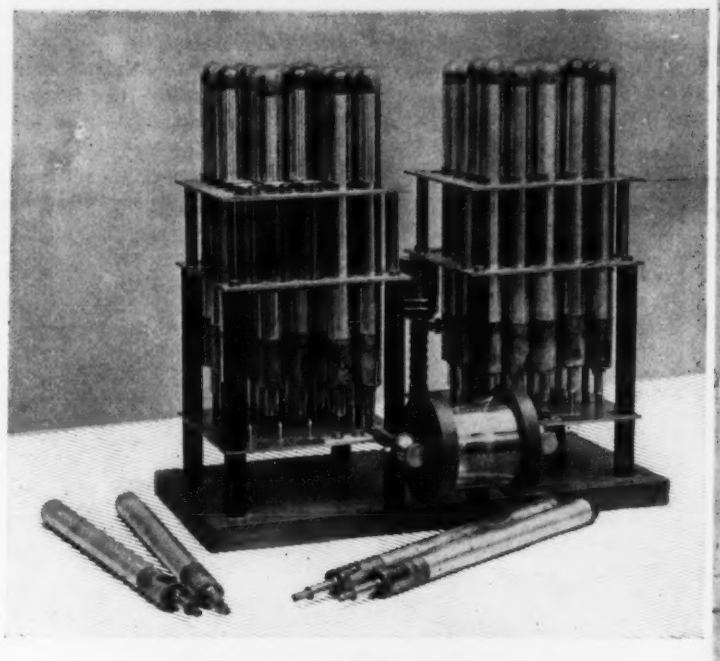


FIG. 4.—ADJUSTABLE CAPACITIES.

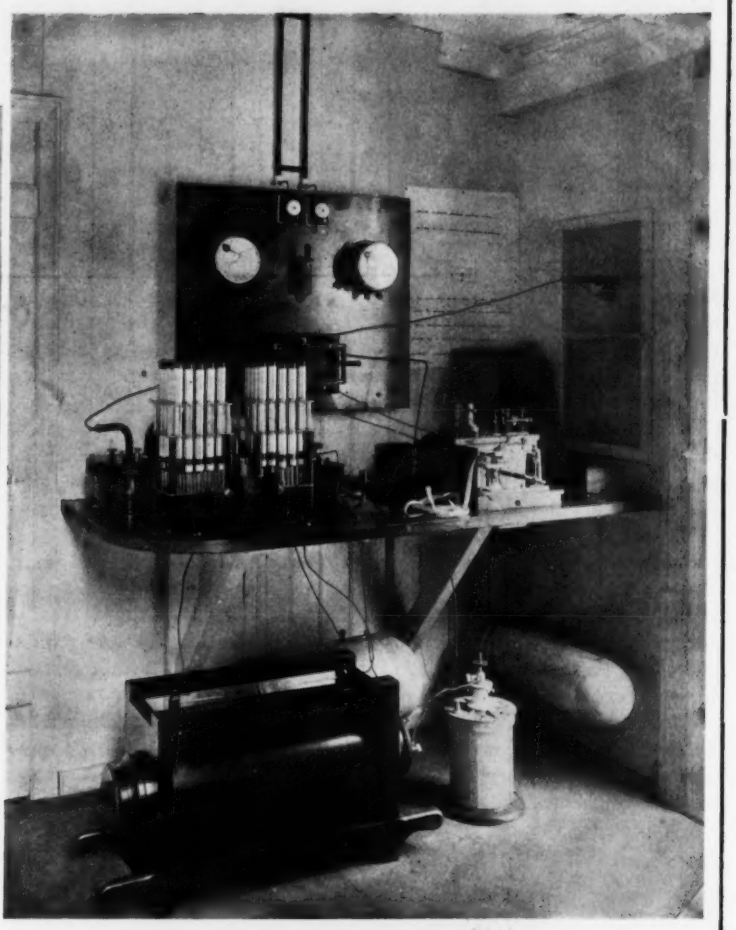
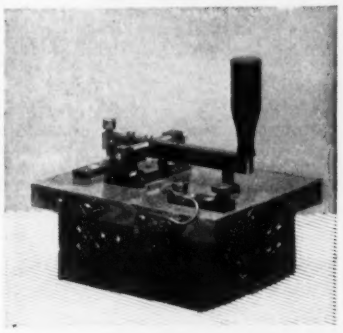
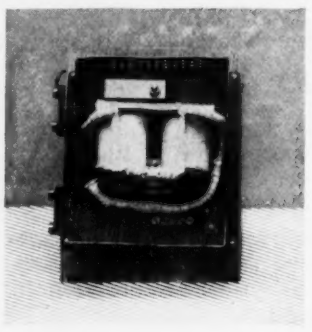


FIG. 7.—INTERIOR OF STATION.





FIGS. 5 AND 6.—SPECIAL KEY FOR HEAVY CURRENTS.

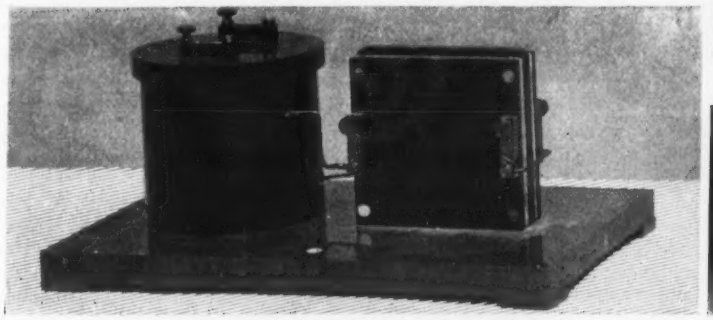


FIG. 9.—CONDENSER APPARATUS FOR RECEIVING SYSTEM.

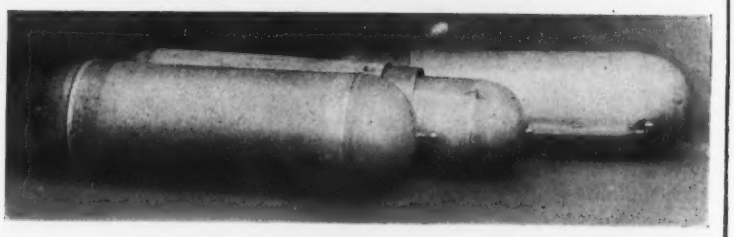


FIG. 8.—CYLINDERS ACTING AS CAPACITY AND REPLACING OPENING WIRE.

APPARATUS OF THE BRAUN-SIEMENS & HALSKE SYSTEM OF WIRELESS TELEGRAPHY.

transformer one terminal will be seen to connect with one of the contacts of the large double-throw, double-pole knife switch; the other terminal of the transformer secondary connects with the cylindrical capacity suspended under the table. The purpose of the switch is to put the antennæ into electrical connection with the receiver or transmitter as desired. The switch is shown connecting the antennæ with the receiving apparatus, the antennæ passing via the window to the yard-arm of the mast. The wire connected to the upper right hand

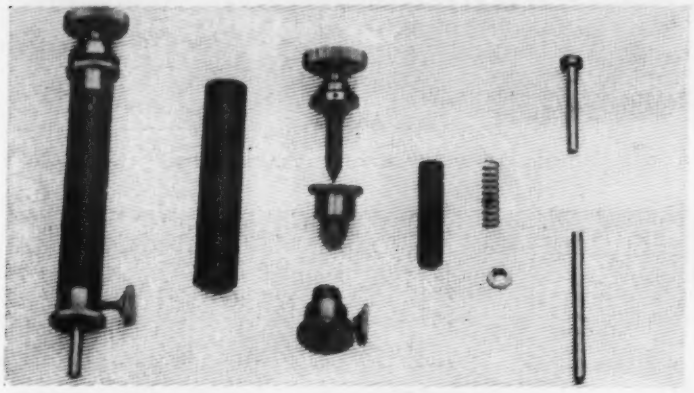


FIG. 10.—ELECTRIC WAVE DETECTOR AND PARTS.

contact of the switch leads to the primary of the receiver transformer and condenser, the opposite terminal ending in the second suspended cylindrical capacity under the table. One terminal of the secondary coil of the receiver transformer is coiled up loosely and in the opposite a coherer intervenes, the relay tapper and Morse register working on an internal battery circuit.

The two wires from the lower contacts of the switch are connected direct to the coherer, so that when the switch is open or when it is thrown into contact with the transmitter, the receiver is not only disconnected but the coherer is cut out entirely from all other portions of the apparatus. The cylindrical capacity areas to which the lower arm of the open circuit oscillator and closed circuit resonator are attached, instead of to the earth as in all other commercial systems, are shown more clearly in Fig. 8. Each capacity is really formed of two cylinders, arranged to slide telescopically, one within the other, so that the value of capacity may be varied within certain limits.

The transformer of the compound resonator circuits, together with its condenser, Fig. 9, is made on a much smaller scale than the transformer and condenser of the oscillator circuit, since the impressed e. m. f. in the resonator circuit must be necessarily smaller than in

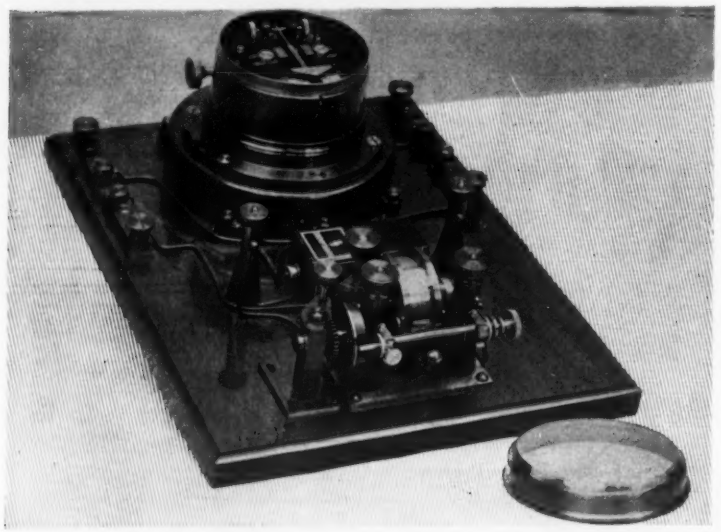


FIG. 11.—POLARIZED RELAY, TAPPER AND COHERER.

the oscillator emitting the waves, though the periodicity of oscillation may be much higher, since the resonator will respond to oscillations having a frequency of some multiple or sub-multiple of the emitted wave length. The condenser is of the standard mica-and-tinfoil type, and is not adjustable.

The electric wave detector is one of the especial features of the Braun system, and is shown completely dissected, as well as the various parts assembled in the finished coherer in Fig. 10. The differentiating element in this coherer lies in the fact that it is not exhausted, and its mechanical construction is therefore based on widely divergent lines from detectors of the orthodox type.

The adjusting screw having a lock nut follows, and immediately below it is shown the upper plug-end, which is threaded and screws into the containing tube, whilst at the bottom is the lower plug-end with a set screw. The smaller ebonite tube, containing hardened and sieved steel powder, slides within the containing tube; the two conductor plugs, made of polished steel, are shown to the extreme right. The lower conductor-plug is held firmly in place by the set screw in the lower end-plug. The spiral spring is now passed over the upper conductor plug with the washer, and these into the containing tube with the end of the conductor plug pressing against the filings. The upper end-plug, the bore of which is tapped, is now screwed into the containing tube, and the adjusting screw inserted until its point comes in contact with the upper conductor plug. The degree of sensitiveness desired may be arrived at by the careful manipulation of the adjusting screw, the spring forcing the conductor plug away from the filings, and the screw pressing it toward the opposite plug. When the proper adjustment is secured, the jam nut is tightened and the coherer is ready for use.

The polarized relay, tapper and coherer are clearly defined in Fig. 11; the relay is of the Siemens type, with permanent magnets made of the finest grade steel, the magnet coils being wound to high sensibility, and the whole forming an instrument of the highest efficiency.

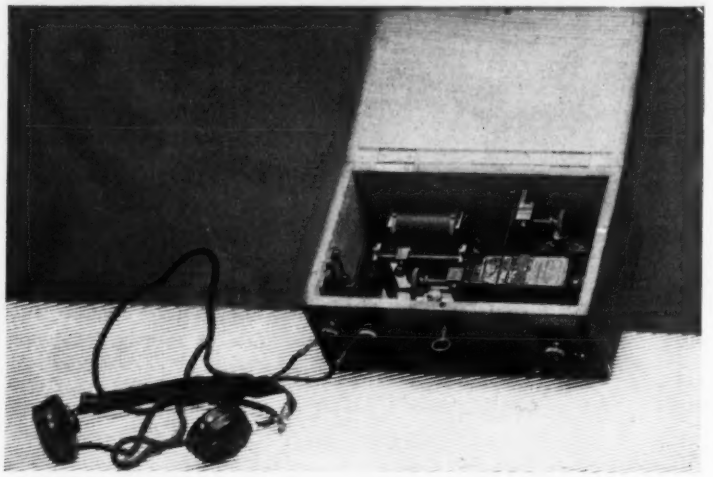


FIG. 12.—PORTABLE RECEIVING SET.

It is enclosed in a metal case, which is dust-proof as well as wave-proof.

A glass cover is provided as well as a screw extending through the case, thus permitting the adjustment of the various contacts to be made outside without difficulty.

The coherer, together with an electro-mechanical tapping device, employed to decohere the filings, is also shown in Fig. 11. This arrangement renders the operation of tapping the tube entirely independent of the derived circuits, the spring mechanism actuating the hammer when the register is receiving a message. It is evident that the force with which the blows are delivered by the decohering striker is always uniform, and that the filings will be rearranged after each successive stroke, in relatively the same position. The instant cohesion of the filings is effected, a trip-catch is released electrically, and the mechanism is set in motion; when decohesion takes place, the catch drops automatically, stopping the spring motor. The relay and coherer are operated by means of a single dry cell. The coherer may be easily and quickly placed in electrical connection with the relay circuit and the secondary of the receiver transformer by slipping it into place between the opening clutches forming the contacts.

The portable receiving set, shown in Fig. 12, may be kept close at hand in emergency cases, for signaling over longer distances than is possible with the Morse registering apparatus, or again it may be employed for field use where a receiver of extreme lightness is desired. In any event it forms a most necessary auxiliary appliance for a wireless telegraph system, aiming to give first-class service under the varying and trying conditions such as are imposed upon commercial systems.

Efficiency of Electric Furnaces.

One of the more practical papers read at the recent Niagara meeting of the American Electrochemical Society was presented by Prof. J. W. Richards, Ph. D., with the above title. Below we print a fuller abstract of the paper than appeared in our report of the meeting:

An electric furnace is a furnace for accomplishing a physical or chemical change in materials by means of the agency of heat, said heat being supplied by the transformation of electrical energy. The cases where electrolysis takes place in fused electrolytes are left out of consideration, because they are essentially electrolytic processes in which the heating of the current is unavoidable and incidental to the main process of electrolysis, and must be excluded from the terms "electric furnace processes" if that term is to retain its individuality and stand for a definite class of operations. If this limitation is understood, the output of an electric furnace is more or less proportional to the amount of heat energy developed in the furnace. It is necessary to say "*more* or *less* proportional," because, although the amount of heat necessary to produce the change in a given amount of material may be a perfectly definite quantity, yet the proportion of the heat developed in the furnace which is actually absorbed or applied in producing this change is a variable one, being always less than 100 per cent., and frequently very much less. The proportion of the heat energy of the electric current thus applied to producing the useful change in the charge is called the *efficiency* of the furnace.

The usefully applied heat will include one or both of two factors. The first is the amount of heat necessary to heat the charge up to the temperature of the furnace. The second is the heat absorbed in chemical reactions between the constituents of the charge when they are heated to the reacting point. This second part of heat can be calculated from thermochemical data, while the former part of heat—that required for the purely physical charges—can be calculated from the mass of the charge, the specific heats in the solid and liquid states, the latent heat of fusion and the temperature of the furnace.

The efficiency of an electric furnace operation depends on many factors, among which are the following: size of furnace, temperature of reaction, protection from radiation, management of the terminals, feeding and tapping, general management. Of these the most important, in commercial practice, is the size of the furnace. The volume or contents of a furnace increase approximately as the cube of the linear dimensions, while the radiating surface which conditions the loss of heat, increases as the square of the linear dimensions; therefore, the proportion of radiating surface to unit of contents *decreases* approximately in proportion as the linear dimensions are increased. It is probable that if a 100-hp electric furnace works at an efficiency of 50 per cent., with the other 505 lost by radiation and conduction, then an 800-hp furnace of the same design working the same process at the same temperature, should give an efficiency nearer to 75 per cent. Most of the desiderata of commercial success of electric furnace work lie in the direction of increasing the size of the furnaces to the furthest limit set by mechanical or physical consideration.

While electric furnaces are generally classified into the resistance type and the arc type, it is better for the present purpose of calculating the efficiency to use a different classification. All furnaces are divided into two large classes. The first class includes these furnaces in which the charge is simply heated without any *chemical* change taking place; the second class includes those in which besides the heating of the charge there is also a chemical change. Each class may be again subdivided into two sub-classes according to whether the heating takes place with or without a melting or fusion of the charge.

Heating Without Fusion and Without Chemical Change.—An example of this is the conversion of anthracite coal into graphite in the Acheson furnace. It is true that some chemical changes probably occur during the conversion, such as the progressive formation and decomposition of carbides, but these are negligible because of their plus and minus heat quantities neutralize each other; the change from amorphous carbon to graphite is a heat *evolving* reaction, and, therefore, must be reckoned as really *assisting* the current or, practically, diminishing in our figuring the calculated efficiency. The data* are as follows: 1,000 hp in 20 hours convert 12,000 lbs. of anthracite into 10,000 lbs. of graphite. The heat gained in conversion into graphite is about 10 per cent. of the heat supplied by the current; hence the real amount of heat is 110 per cent. of the heating power of the current, of this 82.5 per cent. are utilized, giving an efficiency of 82.5 ÷ 110 =75 per cent. In the Acheson process of graphitizing electrodes by placing them crosswise, embedded in a resistant material, 1,000 hp graphitize 7,000 lbs. of electrodes, embedded in 7,000 lbs. of granular carbon and lining; the net efficiency of the operations is 38 per cent.

Heating With Fusion, but Without Chemical Change.—The Jacobs process of fusing calcined bauxite is an illustration. The process is simple fusion by the arc, in a cylindrical pot. With a charge of 3,000 lbs. the efficiency is 74 per cent.

Heating Without Fusion, but With a Chemical Change.—The manufacture of carborundum is a good example. A mixture of carbon, silica sand and salt is heated by the incandescence of a conducting carbon core, until the salt is volatilized, carrying off most of the metallic impurities as chlorides, the silica is reduced and combines with the excess of carbon present to form silicon carbide. The furnace is 20 feet long and 1,000 hp is passed through for 36 hours. The calculation of the efficiency gives 76.5 per cent.

Heating With Fusion and With a Chemical Change.—There are numerous instances of this kind of electric furnace operations, in which particularly reductions to metal or other metallic compounds are operated. An example is the production of calcium carbide, for which the calculation gives a net efficiency of 62 per cent. There is, however, a distinct experimental gap in the lack of knowledge of the specific heat of such products of the electric furnace, at high temperatures. When these are known, calculations of the efficiency can be made with much greater exactness.

The net result seems to point to a commercial efficiency of 60 to 75 per cent., calculating with furnaces of 200 to 1,000 hp. The value of such an approximate figure is that anyone starting an electric furnace operation should be able to calculate the approximate output to be expected or if planing, or designing for a given output, will have a guide to indicate the approximate size and capacity of the furnaces needed.

* Concerning the exact calculations the reader is referred to the complete paper, which will be published in Vol. II of the "Transactions of the American Electrochemical Society."

CURRENT NEWS AND NOTES.

CABMEN AND TROLLEYS.—The cab drivers of Washington have been trying to break up the business of a concern that is running what is termed "Seeing Washington" cars in a continuous trip over all the lines of one of the street-car companies in order to take in all the sights of the capital. The cabmen allege that the cars are run in violation of the charters of the street-car companies and of the general law regulating such traffic. The District Attorney has rendered a decision sustaining the concern running the cars in dispute.

U. S. PATENT OFFICE.—The report of the Commissioner of Patents for the year 1901 shows total receipts of $1,449,398 and expenditures of $1,297,385, leaving a balance of $152,012, which goes to a surplus fund already amounting to $5,177,458. The total number of applications was 52,912, and the total number of patents issued was 27,292. Connecticut led in concrete invention, having obtained one patent to every 1,198 inhabitants. Then comes District of Columbia with 1,296; Massachusetts with 1,472, and New Jersey with 1,572. In South Carolina the number is over 28,000, and in Alaska over 31,000. Of foreign countries, Germany comes first, as 1,045 of her citizens took advantage of our patent laws. England is next with 986, Canada 376, France 306 and Austria 156.

LIGHTNING RESEARCH.—Mr. Killingworth W. Hedges honorary secretary of the Lightning Research Committee, organized by the Royal Institute of British Architects and the Surveyors' Institution, is making a short visit to the United States in the interest of the work of the committee. The committee was appointed for the purpose of obtaining trustworthy information on disasters from lightning with a view to improving, if possible, the means of protection. In pursuance of this inquiry, the committee seek the co-operation of competent observers, in order to obtain accurate details, noted on the spot, of the effect of lightning strokes on buildings, whether fitted with lightning-rods or not. A schedule of questions is supplied to observers, on which to make their report. Those willing to act as observers are requested to investigate any disaster occurring from lightning in their neighborhood, and communicate the results to committee, at 9 Conduit Street, London, W. Copies of the schedule will be forwarded upon application at the above address.

"HELLO" FOR CABS.—To facilitate the calling up of vehicles, telephones are to be erected on or near all the cab ranks in Berlin.

WIRELESS TELEGRAPHY AT CHERBOURG.—A wireless telegraph station, it is said, will shortly be erected at the Auberville Lighthouse, near Cherbourg. Private messages will be received and transmitted, and the station is expected to be of great service to the steamship companies making Cherbourg a port of call.

ELECTRIC WORK AT NAPLES.—The new electric station at La Bufalo, Naples, Italy, is designed for 10 three-phase alternators of 500 kilowatts each. At present only two of them are installed by Gio. Ansaldo, of Cornigliano, Ligure. These are the largest generators ever built in Italy. They are direct connected to Neville triple-expansion steam engines. The maximum voltage is 8,650 volts.

INTERNATIONAL WIRELESS TELEGRAPH CONFERENCE.—Germany, according to a special despatch, is initiating an international conference on wireless telegraphy. The practical working of the system being assured, it is held that rules similar to those of the international telegraph convention should govern the new method of transmitting intelligence. It is suggested that the conference be held during October.

WIRELESS TELEPHONY.—A cable dispatch from Berlin, of September 20, says: Encouraging results of wireless telephony have been obtained on the Wannsee Lake by Ernest Ruhmer, the psychist, who followed the line of Prof. Graham Bell's experiment with light. Clear and comparatively loud sounds were heard a distance of four and even seven kilometers, respectively, about two and a half and four and a quarter miles. Herr Ruhmer's invention is said to act on the principle of the transformation of light waves by using a searchlight and a microphone.

ELECTRIC ROADS IN ITALY.—Ganz & Co. write us as follows from Buda Pest, under date of September 13: "We beg to inform you that traffic on the Sondrio-Colico-Chiavenna line of the main electric railway, which we have built in upper Italy was opened on September 4, and that since that time the regular express, passenger and freight traffic on the line has been carried on without the least hitch. There are 30 trains daily running on the line. The electrical working of the branch line Lecco-Colico, will begin in a few days." This is a three-phase induction motor system, in regard to which details have been given in these pages from time to time.

MECHANICAL TRACTION IN PARIS.—Consul Thornwell Haynes writes from Rouen, August 29, 1902, as follows: According to last year's census, Paris had 96,698 horses which could be utilized in case of war, this having been the average figure for many years; but this year the number has suddenly fallen to 90,796. This considerable diminution is said to be due to mechanical traction. The Paris Omnibus Company had last year 16,579 horses in its service; now it employs nearly 2,000 less. In all the companies which compete with the tramways and the Metropolitan Railway, the diminution of horses has been 2,727. The remaining 3,175 horses which, since last year's census, have passed out of service have, therefore, it is said, been replaced by automobiles.

AN ELECTRICAL TRADE DIRECTORY.—In neat and handy form there has been issued this week by ELECTRICAL WORLD AND ENGINEER a useful directory, which hereafter will be published regularly in January of each year, and will contain the names of the current advertisers in the pages of this journal, at the time of its publication. Including practically all the American manufacturers and dealers having anything of value to offer to the users of electrical apparatus and material, the directory will serve a useful purpose as a reference list for inquirers and prospective buyers. No charge is made to advertisers in the journal for this additional service, which will, we venture to believe, be appreciated both at home and abroad. With this idea, a free copy is also being sent to every subscriber.

CUTTING A FRENCH CABLE.—News has been received from Venezuela that Gen. Velutini, acting as special delegate of the Caracas Government, has caused the arrest of the manager of the office of the French Cable Company at Carupano, as well as the company's clerks at that point. The French consular agent at Carupano, who intervened on behalf of the manager and clerks of the cable company, was also placed under arrest. The cable office at Carupano is closed, and coastwise cable communication has been interrupted for the last five days. The Venezuelan cruiser "Restaurador" is suspected of having cut the French cable in order to prevent the revolutionists from using it. The managers of the office of the cable company, at Caracas and La Guayra, have protested against what they term the "arbitrary action of the government." M. Quieveux, French Consul at Caracas, has also protested strongly against the arresting of the cable employees at Carupano and the cutting of the cable without notice. U. S. Minister Bowen, under date of September 28, has cabled from Caracas to Washington his belief that the Venezuelan Government intends to cut all the cable lines this week.

A SWIFT MILE.—World's records were smashed at Narragansett Park during the second annual race meeting of the Rhode Island Automobile Club. Despite execrable weather, Mr. George C. Cannon was the sensation of the day. He clinched his title to the steam championship of the world by driving the famous car of his own construction in 1:05¼, the fastest mile ever made over the Narragansett Park track. The previous world's record was 1:07⅖, held by Mr. Cannon himself. Then, to complete his fame, the young Harvard student set a new world's record for steam cars for five miles, at 6:05 flat, reducing the previous mark from 6:43, made recently at Cleveland, by Rollin White. Cannon's time by quarters for his world's record was 0:16½, 0:33, 0:49½, 1:05¼. His five-mile record was 1:12½, 2:26¾, 3:41½, 4:54, 6:05. The open class for electric carriages, two miles, was won by Mr. Knight Neftel, in a car of his own make. His time was 4:23. Mr. Alexander Winton and his "bullet" in the five-mile race broke the track gasolene record, the first time around in 1:06½. The second mile was in 1:05¾, the third in 1:06½, the fourth in 1:06¼, and the fifth, the fastest, in 1:05⅗.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—Secretary Cahoon reports the following new members since August 18, 1902: Albion, N. Y., Albion Steam Power Company; Attleboro, Mass., Attleboro Steam and Electric Company; Athens, Ga., Athens Electric Railway Company; Beverley, Mass., Beverley Gas and Electric Company; Brookline, Mass., Brookline Gas and Electric Company; Carbondale, Pa., Lackawanna Valley Electric Light and Power Supply; Cohasset, Mass., Cohasset Electric Company; Duluth, Minn., Duluth General Electric Company; Doyleston, Pa., Doyleston Electric Company; Elwood, Ind., Elwood Electric Light Company; Everett, Wash., Everett Railway and Electric Company; Lee, Mass., Lee Electric Company; Lynn, Mass., Lynn Gas and Electric Company; Oneonta, N. Y., Oneonta Light and Power Company; Oil City, Pa., Citizens' Light and Power Company; Southern Pines, N. C., Biscoe Electric Light Plant; Telluride, Col., Telluride Electric Light and Power Company; Walla Walla, Wash., Walla Walla Gas and Electric Company; Warren, Ohio, Warren Electric Light and Power Company; Westboro, Mass., Westboro Gas and Electric Company; Whitman, Mass., Whitman Light and Power Company.

LETTER TO THE EDITORS.

Paralleling of Alternators.

To the Editors of Electrical World and Engineer:

Sirs.—The letter from Mr. G. Rosenberg which appears in your issue of August 2, and your abstract of Mr. Longwell's paper to which it refers, interests me very much, as I have for some time been of the opinion that the usually accepted ideas as regards the influence of uneven turning moment on parallel running are erroneous.

I called attention to this point in a contribution to the discussion on a paper read before the (British) Institution of Electrical Engineers, and published in Vol. XXX of the *Proceedings* (May, 1901), and subsequently in an article appearing in the London *Electrical Review*, April 4 and 18, of the present year, I entered more closely into the matter, and showed by a method different to that of Mr. Longwell the important result which he has so clearly put forward, namely, that the effect of the synchronizing force is to *increase* the phase displacement and therefore the irregularity of angular speed of an engine instead of to diminish it. I am glad to know that Mr. Rosenberg has also arrived at the same result, and I look

forward with interest to reading his paper as soon as the translation referred to by him is published.

Mr. Longwell does not in his paper bring out clearly the dependence of this effect on the moment of inertia of the flywheel, etc. In the article referred to above I showed that this increase in the cyclic irregularity only takes place provided the moment of inertia exceeds a certain amount depending on the conditions of the case, but though the data I possess are not conclusive, I am inclined to think that, with the flywheel proportions which are usually adopted, this limiting moment of inertia is exceeded.

In conclusion, I should like to draw attention to the question of frequency in relation to parallel running, concerning which it is commonly held that the parallel running of generating sets of a given flywheel power is facilitated by low frequency, and one sometimes sees it stated that it is obvious that this should be so.

But if the reasoning on which this statement is based, as given in many textbooks and papers, be examined it will be seen that it involves the assumption that the phase displacement of a generating set when running in parallel is not greater than when it is running alone on a load offering constant torque. It has been shown that this assumption is not tenable, and it would therefore appear that the usual statement that the parallel running is facilitated by low frequency is not justified in the present state of the theory.

Newcastle-on-Tyne, England. H. C. Leake.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

Heating of Toothed-Core Armatures.—Davies.—A discussion of the reason why in practice toothed-core armatures are sometimes found which show an excessive heating. He has found that such overheating is more marked in machines of the multipolar than of the bipolar type, especially in the smaller sizes, and that the temperature rise is not at all proportional to the load in the machine, but is more marked at light load than at full load. Sometimes it occurs that the overheating is brought about by insufficiency of iron in the teeth. Furthermore, the hysteresis and the eddy current losses are the greater, the greater the number of cycles of magnetization through which the iron passes per second; hence the frequency must be kept as low as possible, and herein lies one of the advantages of a slow-speed machine; moreover, to keep the frequency low, it is advisable to have as few magnet poles as possible. There is also another reason why the iron losses are greater the greater the number of poles in a machine for a given speed; the number of teeth embraced by a magnet pole is not exactly in inverse proportion to the number of magnet poles, but is rather less than this, becoming less and less as the number of poles is increased. For this reaon, the magnetic induction in the teeth become greater as the number of poles is increased. This will not matter much if, as should always be the case in the armatures for multipolar machines, the radial depth of the armature core, and, consequently, the radial depth of the teeth is proportionately less, for then the teeth will be proportionately wider at the roots. It is, therefore, always necessary to carefully calculate the watts lost in the armature teeth. For the purpose of estimating these losses, the mean average magnetic induction in the armature teeth may be taken as being equal to that at one-third the length of the teeth, measured from the roots. As a set-off against the increased losses in this direction which accompany an increase in the number of poles, the current density in the conductors and, therefore, the Joulean heat loss is usually smaller in the larger sizes of machines, in which an increase in the number of poles is permissible.—Lond. *Elec.*, September 12.

Commutation.—Punga.—An illustrated mathematical article on the theory of commutation. While formerly the commutation was assumed to depend only upon the e. m. f. induced in the short-circuited coil, it has since been assumed that the transition resistance from the commutator segments to the brushes, has a great influence. The author discusses the principles of commutation and develops a formula for practical use. He claims that it is less the transition resistance itself which influences the commutation, but its combination with a non-uniform distribution of the current density under the brushes.—*Zeit. f. Elek.*, July 27, August 3, 10.

Squirrel-Cage Armatures of Induction Motors.—Osnos.—A brief illustrated article. In general, the copper bars of a squirrel-cage armature are connected at both ends by short-circuiting metal rings. As the air gap is often small and the armature bars have a small electric resistance, a small eccentricity of the rotor can be of a great disadvantage. This disadvantage can be greatly diminished if the short-circuiting ring is not made of one single piece but consists of several segments insulated from another; it is best to use a number of segments equal to half the number of the poles of the primary. It is possible to divide into segments only one instead of both short-circuiting rings, and to make the other of one piece, as usually. A small insulation is sufficient, even a layer of oxid may be enough. Another arrangement in a four-pole motor is to divide both rings into two halves, but the diameters along which they are cut are perpendicular to each other at the two ends; this arrangement is said to have given good results in practice and to have improved the starting torque.—*Zeit. f. Elek.*, August 10.

Transformer Reactance.—An anonymous article on a practical method of calculating the short circuit reactance of transformers of ordinary design. The fundamental fact made use of is that when the secondary winding of a transformer is short circuited and an alternating current is passed through the primary, then the induced secondary ampere turns are equal and opposite to the primary ampere turns, which fact holds good for any transformer not having unreasonably high reactance. The short-circuit reactance may then be considered as due to the magnetic leakage flux in the region between the primary and secondary sections, which is induced by the primary and secondary ampere turns. The total reactive voltage is equal to the effective cutting of the primary and secondary windings by this flux, the e. m. f. being generated half in the secondary and half in the primary. The problem is to determine the short-circuit reactance as a function of the following quantities: primary current, primary turns and frequency; dimensions of windings and sheath; relative arrangement of primary and secondary windings; disposition of the induction. The respective formulas are given.—Lond. *Elec. Rev.*, September 5.

References.

Voltage Drop in Alternators.—Westphal.—A long mathematical article, illustrated by diagrams. He gives a highly analytical solution of the following two problems: To determine the voltage drop of an alternator, when loaded, and to determine the excitation required to compensate for this voltage drop. The general formulas which are given look very complicated, but he gives a numerical example to show that they can be used in practice. He also shows that this method can be used to obtain information concerning secondary phenomena in alternators.—*L'Eclairage Elec.*, August 2.

Electromechanical Compounding.—Guilbert.—A very long and well illustrated description of the method of electromechanical compounding of electric generator sets by means of the Routin regulator, the characteristic features of which are the use of a single device to control the mechanical regulation and the electric regulation, and the use of a special device for automatic control.—*L'Eclairage Elec.*, August 9, 16.

Tramway Motors.—Field.—The conclusion of his long illustrated paper, the first parts of which were recently abstracted in the Digest. He deals with acceleration and braking.—*Lond. Elec. Eng.*, September 5.

Efficiency of Transformers.—Ballard.—An illustrated article on methods of testing the efficiency of transformers. The determinations of the core loss and of the copper loss are described.—*The Eng.*, September 15.

Regulator of Shunt Dynamos.—Dick.—An illustrated article on

the determination of the number of steps and their resistances, for the regulator of a shunt wound dynamo with self-excitation.—*Zeit. f. Elek., August* 10.

LIGHTS AND LIGHTING.

Osmium Lamp.—ZIEGENBERG.—A review of recent progress made with the Nernst lamp and the osmium lamp. A number of patents for the Nernst lamp are described, and it is pointed out that for practical purposes a compromise must be made between the requirement of cutting the heating body out of the circuit when the lamp is lighted, on the one hand, and the requirement to avoid complicated construction on the other hand. The trouble with the osmium lamp is that osmium is rare and expensive and is very difficult to work economically. The osmium lamp will be rented only, and not sold, by the Welsbach Company for some time, so that the company retains possession of the osmium and can use it again. The following method of Deville and Debray for making the osmium wire is described. It is based upon the observation that if osmium vapors are sent through a tube of clay, the inner side of which is coated with an adherent layer of carbon, the tube being heated to incandescence, then osmium is deposited and replaces the carbon, *i. e.*, the carbon layer is changed into an osmium layer. By this method there is only a very small loss of osmium. For making osmium wires, carbon threads are placed in a case of clay; the air is driven out by means of nitrogen, and $Os\ O_4$ is introduced either in solid form or by means of a current of inert gas (nitrogen); the case is then heated to a high temperature, causing the carbon threads to change gradually into osmium threads, the change taking place in the direction from the outside to the center. Very thin osmium threads can be made in this way, which is of importance, as it facilitates making lamps for the higher voltages. Another trouble is that the osmium filament has a relatively great length and must be supported. Mixtures of certain refractory oxides are recommended for the supports. Another solution of the problem of making osmium filaments for normal voltage and of such a rigidity that the incandescent filament does not change its form, is due to Auer von Welsbach. He uses the osmium wire in the form of a spiral of fine wire. This spiral must consist of windings of very small diameters, only a few millimeters. This spiral is supported and held in its form by means of a thread of mixtures of refractory oxides. The osmium wire is made by preparing a paste of osmium and certain other materials, and forcing it through a die. Single windings of this spiral of fine osmium wire may be in direct contact, without diminishing the incandescence of this winding, *i. e.*, the contact does not represent a serious shunt. —*Zeit. f. Beleucht,* August 30, September 10.

REFERENCE.

Lighting of a Freight Station.—JORDAN.—An illustrated description of the electric equipment for lighting a freight station of an Austrian railway. The three-phase system is used with 950 volts between two phases, the frequency being 42. There are 62 arc lamps of 20 amperes and 12 of 16 amperes.—*Zeit. f. Elek.,* August 10.

POWER.

Australian Power Scheme.—CROCKER.—An article on the power plant, the principal purpose of which is to supply electric current to the mines in the Kalgoorlie district for power and lighting purposes. The plant is now rapidly nearing completion, and the tramways have already been supplied with power. The electric portion of the plant consists of three 500-kw, 600-volt, 40-cycle, three-phase generators, direct coupled to steam engines. For supplying the tramway system, two 250-kw synchronous converters are used. The general distribution to the mines for lights and stationary motors will be direct from the 550-volt, 40-cycle, three-phase system. As the equipment of each portion of the plant is divided into three or more units, one of which is always to be held in reserve, the power supply will be of a reliable character. With the machinery at present installed, the company is able to supply some 2,000 hp in motors, in addition to the power required by the tramways. The entire electric equipment is by the General Electric Company of this country.—Lond. *Elec.,* September 5.

Colorado Power Transmission.—JONES.—An illustrated article on the Pikes Peak power transmission in Colorado. There will be three hydro-electric stations, one of which is completed. It contains four 400-kw, 600-volt, 30-cycle, three-phase alternators, direct connected to water wheels. The line voltage is 12,600. The line leads to the substation, adjoining the Gold Coin ore house in Victor, which supplies current to the city and mine. The high-pressure lines leave the substation in various directions to other mines and mills.—*Jour. of Elec.,* September.

TRACTION.

Direct 3,000-Volt, Three-Phase Traction in Italy.—A note stating that as the Colico-Sondrio and the Colico-Chiavenna sections of the Valtellina Railway in Northern Italy have now been running for some months past as experimental lines, the government has granted the necessary permission to operate a daily regular service of pasenger and goods trains. The feature of the installation is the use of 3,000-volt, three-phase, alternating currents as the working pressure of the motors, power being supplied to the line from a generating station which utilizes the water power of the falls of the Adda River, the transmission line pressure being 20,000 volts. The length of the lines now actually working is about 100-km, and it is only on account of the goods results shown by the tests, that they have at last been officially sanctioned. One of the worst dangers anticipated was in respect to fire consequent on the high-tension trolley wire snapping and falling on the trains, should the safety device fail to act. During the test, however, the automatic cut-out has given great satisfaction, the 3,000-volt trolley wire having been allowed to fall on the roof of the train without doing the slightest damage.—Lond. *Elec.,* September 12.

City and Surburban Electric Traction.—MOMMERQUE.—An abstract of a report to the French Ass. Adv. Sc., in which he reaches the following conclusions. The simplest system of electric traction are the third-rail system for railways and the trolley system for tramways. Although the trolley automotor system (cars not running on rails, but taking current from overhead wires by means of special devices) starts from the same principle, it can be used in cities only in exceptional cases. Storage batteries on tramway cars too heavy are too expensive; they should be used only in exceptional cases where the batteries can be replaced after a relatively short run and charged slowly under good conditions of supervision. Where it is impossible to run a trolley system throughout, a combined trolley and conduit system is recommended.—*L'Eclairage Elec.,* July 26.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Agricultural Electric Installation.—ROTH.—An illustrated description of an installation of an Austrian farm where electric power is used for ploughing, and also for lighting 300 lamps and driving a pump and an agricultural machine. As the latter two are only working at long intervals, they are on the lighting circuit, while for ploughing a separate circuit is used. There is a small water power available giving 500 liters per second at a height of 8 meters; a 40-hp turbine is used, running at 275 r. p. m. To improve the uniformity of revolution, a 1,000-kg flywheel is mounted on the shaft of the turbine. With the turbine is connected two sets, each consisting of two electric machines. The larger set is of a 65-kw, 2,100-volt, three-phase dynamo and a 40-kw, 110-volt, direct-current dynamo, while the smaller set is a 10-kw, 2,100-volt, three-phase dynamo and an 11-kw, 110-volt, direct-current dynamo. There is also a battery of 60 cells of accumulators, giving 987 amp.-hours in seven hours. The 65-kw, three-phase machine gives the current for ploughing, the 10-kw, three-phase machine for lighting. While current is used for ploughing, the 65-kw, three-phase machine is coupled with the 40-kw, direct-current machine, and the latter is connected with the storage battery. As long as the whole power is not required for ploughing, the battery is charged from the direct-current machine. When more power is required for ploughing than the turbine can give, the battery drives the direct-current machine which then runs as a motor and supports the turbine. If during ploughing, current is required for lighting, the smaller machine set is used, which, however, is then disconnected from the turbine, in order to avoid fluctuations of the light, due to sudden changes of the ploughing load; the 11-kw direct-current machine is then driven as a motor from the battery, and drives the 10-kw, three-phase machine which gives the lighting current. When the ploughing is finished, the 10-kw, three-phase machine and either of the two direct-current machines are driven by the turbine, the former gives the current for lighting, the latter for charging the battery. For ploughing, the following system is used. At one side of the field is placed the car with the motor, which drives a steel rope along which the plough is running. The speed can be reduced to 10 per cent. of full speed by means of a regulating resistance. The steel rope runs from the car with the motor to another car at the other side of the field and back. The progress from one furrow to the next takes place nearly

automatically by means of only two switches. The installation is said to work very satisfactorily.—*Zeit. f. Elek.,* August 31.

REFERENCES.

Electric Installation in a Theatre.—An illustrated description of the application of electric current for power purposes and for lighting at the Covent Garden Opera House in London.—Lond. *Elec. Rev.,* August 29.

Sparklet Fuse.—Some illustrations, with brief description, of the breaking of a 10,000-volt, 1,000-kw arc by means of a "sparklet" fuse, which was recently noticed in the Digest.—Lond. *Elec.,* August 29.

WIRES, WIRING AND CONDUITS.

Pressure Rise in High-Tension Transmission.—WOODHOUSE.—An article in which he first describes the use and construction of lightning arresters on overhead lines and then discusses the pressure rise which may occur alike in cables and overhead lines, due to switching on and off, and to a change of the current flowing. The stresses of a high-tension system are due to the manner in which the circuit is made or broken; the choice of the switch gear is also of importance. Air-break switches become useless above 10,000 volts, due to the long arc formed and the possibilities of resonance effects. The oil-break switch also breaks the circuit suddenly, but without a long arc; this does not stress the system unduly. The ideal switch-gear should make or break the circuit when the current wave passes through zero. Judging from the fact that disconnected cables are always found to be charged, no switch gear does this. Charging devices, such as a switch by which pressure is gradually applied to the mains, may be effective, but are unnecessary. He thinks the system will be fully protected if spark-gaps be fixed between lines and earth, both on cables and overhead lines, the gaps being set to discharge at from one and a half to twice the working pressure, the lower value for extra high pressures. Transformers and the stators of induction machines—both possessing considerable inductance—should not be switched directly on to the line, but should be shunted by a condenser at the moment of switching in or out. In some experiments which he recently made on spark-gaps, it was found that a row of gaps, arranged to discharge at 3,500 volts, kept the pressure of a line at about that voltage when a pressure of 5,000, 10,000, 15,000 and 20,000 volts was applied for several seconds. At the lower voltage the discharge was spread along the cylinders and was uniform. The higher the applied voltage the greater was the tendency to form large sparks, blistering the metal. Apart from such voltages as might occur from lightning discharge, the gaps acted effectively.—Lond. *Elec.,* September 5.

ELECTRO-PHYSICS AND MAGNETISM.

Electron Theory of Magnetism.—VOIGT.—A paper in which he attempts to apply the electron theory to magnetism. The idea that Ampere's molecular currents consist of electrons revolving around the remainder of the atom was at once suggested by the Zeeman effect, and the author clothes this supposition in a mathematical form. If the electrons are, however, supposed to have a free orbit, then according to the electron theory, no induced magnetism would be possible. The alternative is to suppose that the revolutions or oscillations of the electrons are damped, and this assumption leads at once to the following theorem: "When the electrons of a body move in a constant magnetic field, they produce magnetic effects when their motion (against a resistance) is always interrupted by any irregular impulse and thus maintained at a constant mean energy. The body will then show paramagnetic or diamagnetic properties accordingly as to whether the motion of the electrons after these impulses show, on the whole, a surplus of potential or kinetic energy, respectively." Such impulses must result from collision with neighboring molecules and electrons, since the electromagnetic heat waves sent out in consequence of such collision are compensated.—*Ann. d. Thys.,* No. 9; abstracted in Lond. *Elec.,* September 5.

Deviable Rays of Radioactive Substances.—RUTHERFORD AND GRIER.—An account of an investigation which gave the following results. The three well-recognized radioactive substances, urarium, thorium and radium, all emit both deviable and non-deviable rays. In this respect they differ from polonium, which gives out no deviable rays; there is little doubt that polonium cannot be considered as a permanently radioactive substance, for its radiation steadily diminishes with the time. Uranium gives out more deviable rays than radium or thorium, compared with the amount of non-deviable, but the ratio of the amounts of the two types of rays is of the same order. It seems probable that most of the deviable rays from uranium and thorium are given out by a secondary product produced by a disintegration of the uranium or thorium atom or molecule. These secondary products differ in chemical properties from uranium and thorium, and can be separated from them by chemical means, and thus give rise to the products "Uranium X" and "Thorium X." The non-deviable radiation may be either due to the other secondary product of the reaction, or may be due to an action of the product responsible for the deviable rays in the mass of the radiation material.—*Phil. Mag.,* September.

Temperature and Ionic Shock.—STARK.—An article in which he compares the mean velocity of the charged ions in a gas with that of the neutral molecules. The velocity of a negative electron capable of ionizing a molecule is about 1.9 times the 8th power of 10 in cm. per second, and that of a positive ion 8.6 times the 6th power of 10, while for a temperature of 225° C. the neutral gas molecules of hydrogen, nitrogen and carbonic acid has a velocity of the order of magnitude of the 4th and 5th power of 10. The ionizing ions move, therefore, from 100 to 1,000 times faster than the neutral molecules, and the latter may, therefore, be regarded as at rest with respect to the former. Anything which reduces the density of a gas, such as reduction of pressure or increase of temperature, increases the free path of the ionizing ions. This implies that the absorption of kinetic ionic energy diminishes with increasing temperature and constant pressure, as noticed in the absorption of Lenard rays by gases. He makes some interesting applications of this principle to the fall of the discharge potential and to luminous effects in vacuum tubes. Thus the extinction of the glow near a hot body is explained by the increase of the free path, and the consequently smaller absorption of energy from the moving ions.—*Ann. de Phys.,* No. 8; abstracted in Lond. *Elec.,* September 5.

Tesla Discharges.—WESENDONCK.—A paper in which he criticized the work of Moehlmann on Tesla discharges by ordinary means (Digest August 30). He points out that there is a great difference between a static and an oscillatory discharge; in the former there is a greater negative discharge from a point, while in the latter there is a greater positive discharge. This difference cannot be brought out by placing a plate opposite the point, since the side discharges are too important. Even with an apparently pure negative discharge positive electricity streams out from the sides of the conductor. It is, therefore, necessary, in order to get at the total discharge, to surround the point with a hollow conductor. He describes an experiment with one of Himstedt's Tesla transformers. An Exner electroscope showed nothing but a positive discharge. When the point discharged freely into space a probe or flame collector, mounted on one side, showed no negative electricity, unless an earthed disc was placed pretty close in front of the point at the same time. Here, therefore, the central positive discharge was surrounded by a kind of negative sheath. But a hollow conductor completely surrounding the point only acquired a positive charge, evidently due to an excess of positive electricity.—*Phys. Zeit.,* July 15; abstracted in Lond. *Elec.,* August 29.

Electricity in Raindrops.—SCHMAUSS.—An account of an investigation of the behavior of a jet of water falling through ionized air. Lenard has found that water falling through ordinary, not ionized air upon a metallic plate communicates positive electricity to the plate and negative electricity to the air. The present author finds that on ionizing the air, this effect is obtained by another. The metal plate receives a negative instead of a positive charge, and only after several minutes does Lenard's effect regain ascendancy. Zeleny has shown that when a stream of ionized air is directed against a conductor, the latter, owing to the greater speed of the negative electrons, acquires a negative charge. In the water jet the conductor is moved against the ionized air, and the effect is the same. Moisture seems to favor the absorption of negative ions. The explanation of the earth's negative charge seems now pretty complete. Wilson has shown that negative ions are more effective as nuclei of condensation than are positive ions. His new experiments, as well as those of the present author, show that drops already formed are capable of transporting negative electricity to the earth. All experiments of this kind are complicated by Lenard's effect, which is probably of an electrochemical nature.—*Ann. d. Phys.,* No. 9; abstracted in Lond. *Elec.,* September 5.

Radio-Active Rain.—WILSON.—An account of experiments made to explain why a negatively charged body exposed to the atmosphere becomes radio-active; as this apparently indicates the presence of some

radio-active substance in the atmosphere, he tested whether any of this radio-active substance is carried down in rain. He boiled down freshly fallen rain to dryness and found a radio-active residue. The radio-activity rapidly disappears.—*Proc. Cambridge Phil. Soc.*, Easter, 1902; abstracted in Lond. *Elec.*, September 5.

Sparking Gap Between Plates for Extremely Small Distances.—Earhart.—A paper giving an account of measurements of the sparking distance between plates when very close together. He formerly experimented with direct current, and has now used alternating current of a frequency of 60 cycles. He used nickel-plated surfaces, and also steel surfaces. Curves are given showing the sparking distance as a function of the potential. The curve for the direct current is almost identical with that for the alternating current. Hence he concludes that a given potential is required to cause a spark to pass between such surfaces, and that the character of the potential difference is unessential. The curves show an "elbow," as there is a change in the law at a distance of about "three wave lengths." At distances less than this, the p. d. required to cause a spark to pass seems proportional directly to the distance of separation, but above this point the relation between potential and distance follows a different law. He also made some experiments, in which capacity was introduced into the circuit; the effect of capacity seems to round out the elbow of the curve.—*Phys. Rev.*, September.

Electrical Properties of the Diamond.—Arton.—An article in which he states that while density, hardness and quantitative combination with oxygen, are at present accepted as the necessary and sufficient distinguishing qualities of the diamond, there should be added certain electrical properties, some of which are quite characteristic. The conductivity of the diamond is about the same as that of ordinary glass; graphite has a conductivity about the 15th power of ten times as high. Under the action of Röntgen rays the conductivity of the diamond is doubled, but the original resistance is restored at once on removing the rays. Like ice, diamonds possess a dielectric constant largely in excess of the value warranted by its refractive index. Theoretically, it should be about 7, but in reality it is anything from 10 to 17; he takes this as an indication that the diamond, like ice, retains the dielectric constant it had in a previous liquid state; possibly, also, certain hydrocarbons may be present in small quantities to raise the dielectric constant. Diamonds show residual polarization, and consequent electric hysteresis. It is feebly paramagnetic and pyroelectric.—*Accad. Sc. Torino. Atti.*, 1902; abstracted in Lond. *Elec.*, September 5.

High-Pressure Spark-Gap.—Jervis-Smith.—An account of experiments which show that the use of a high-pressure spark-gap makes the discharge very effective when used to excite the Röntgen effects in exhausted tubes and bulbs having no terminals. He also found that the high-pressure spark-gap, when placed in the secondary of an ordinary induction coil, increases its effects considerably when used as a generator of Hertzian waves.—*Phil. Mag.*, August.

REFERENCES.

Electric Waves.—Morton.—A long and highly mathematical paper on the forms of the lines of electric force and of energy flux in the neighborhood of wires leading electric waves.—*Phil. Mag.*, September.

Luminescence of Metallic Vapors.—Lewis.—An account of experiments, in which he studied the fluorescence of metallic vapors under the influence of cathode rays.—*Phys. Zeit.*, August 1; abstracted in Lond. *Elec.*, August 22.

Hysteresis.—Hiecke; Doery.—A communication in which the former criticizes several points in Doery's recent article on the mathematical deduction of Steinmetz's hysteresis law; also Doery's reply. *Zeit. f. Elek.*, August 17. Another critical communication by Hiecke in *Zeit. f. Elek.*, August 31.

Change of Length by Magnetization.—Honda and Shimiza.—An account of an experimental investigation of the change of length of ferromagnetic wires under constant tension by magnetization; soft iron, wolfram steel and nickel steels were tested.—*Phil. Mag.*, September.

Electro-Chemistry and Batteries.

Electric Smelting of Iron Ores.—A note stating that the possibilities of the electric furnace as a rival of the blast furnace, for the smelting of iron ores, are now being tested at several places in Europe. At Darfo, in Northern Italy, the Stassano process has been under trial, in a plant of 1,500-hp capacity. Dr. Goldschmidt, of Essen, after inspecting the furnaces in operation about a year ago, reported favorably on the prospects of the undertaking. From figures published by those financially interested in the Stassano process in 1899, it would appear that 2.7 hp-hours were expected to yield 1 kg. steel in the electric furnace, and that a saving of $7 per ton of steel was estimated as compared with the cost by the ordinary smelting process in Italy. Whether the liquidation of the company is due to the failure of the Stassano process to attain these results or is simply due to a shortness of working capital is not known. Similar trials of the electric furnace for the reduction of iron ores are being conducted at Prague, in Austria; at Le Praz, in France, and at Gysingen, in Sweden, and at the latter place 1,200 kg. steel are said to be produced per day by the Kjellin process. If steel of good quality can be produced in a single operation by the electric furnace from iron ores of average composition, it is possible that these new processes of one reduction may have an important future.—Lond. *Elec.*, September 5.

Electric Furnace for Making Steel.—Seidener.—An article on a plant in Sweden, for making steel in the electric furnace. The first experimental electric furnace was installed two years ago, and now a larger one has been built. It is said that with a 300-hp turbine directly coupled with a generator, the new furnace will give 1,500 tons per year, which means that 72 hp give 1 ton per day. It is suggested to use the wasted gases of blast furnaces to drive gas engines, and, if the power cannot be used otherwise, to utilize it in electric steel furnaces.—*Zeit. f. Elek.*, August 24.

Rapidity of Electrolytic Decomposition of Oxalic Acid.—Akerberg.—An account of an investigation in which he found that a solution of sulphuric acid, containing oxalic acid, is electrolyzed better between platinized than between polished platinum electrodes, and concludes that the decomposition is, therefore, a secondary process.—Lond. *Elec. Eng.*, September 5.

REFERENCES.

Electrolytic Analysis.—Arth.—A description of the method of Bindschedler for the electrolytic estimation of mercury; the method of Brunck for the estimation of bismuth, and the method of Moltke-Hansen for the separation of lead and manganese.—*L'Eclairage Elec.*, August 2.

Competition of Storage Batteries.—Reyval.—A long account of the detailed results of the recent competition of electric storage batteries by the French Navy, the main conclusions from which have already been noticed in the Digest.—*L'Eclairage Elec.*, August 16.

Units, Measurements and Instruments.

Milammeter.—Schaefer.—The conclusion of his long, illustrated article on the capabilities of the milammeter and the galvanometer in general testing and in submarine cable testing. He remarks that the Weston direct-reading milammeter now leaves nothing to be desired in the way of portability, compactness and reliance, and can even withstand the rough usage that sometimes is inevitable. He makes some suggestions regarding the selection of an instrument, and sums up the general conditions which must be fulfilled, and discusses the use of the instrument as a direct-reading voltmeter. He says that for the greater refinement required in the measurement of currents in the order of a few microamperes, the supreme excellence of the Sullivan galvanometer is indisputable, both for laboratory and ship work, provided care be taken to avoid the Gerard effect. He describes a special shunt which he has constructed and used, and which has the advantage of being a universal one for all Sullivan or other copper-wound proportional deflection galvanometers, while its resistance is also practically constant.—Lond. *Elec.*, September 5.

REFERENCE.

Measuring Instruments.—Armagnat.—An illustrated description, mainly taken from patent specifications or from descriptions in other journals, of new measuring instruments, among which are meters of Blathy-Japy, Japy, Halsey, Hookham, Wright; Tinsley's form of the cadmium standard cell; the hot-wire wattmeter of Bauch; the faradmeter of Willyoung.—*L'Eclairage Elec.*, August 2, 16.

Miscellaneous.

Education of Engineers.—Perry.—The first part of his presidential address to a section of the British Assn., and at the same time the opening of a general discussion of this subject. A mere scientific man analyzes nature, takes a phenomenon, dissects it into its simpler elements, and investigates these elements separately in his laboratory. The engineer takes nature as she is, in all her complexity. He must

have all the knowledge of the scientific man and ever so much more. He uses the methods of the scientific man, and adds to them methods of his own. The name given to these methods of his own or their results is sometimes common sense, or character, or individuality, or faculty, or business ability, or instinct. They come to him through a very wide experience of engineering processes, of acquaintance with things and men. No school or college can do more than prepare a young man for this higher engineering education, which lasts through life. The first essential requirement of a boy who is to become an engineer is that he wants to become one, that he loves his profession. The author then recalls his own studies in his young years, and expresses his obligations to his teachers, especially James Thomson. "To come in contact with any of them, even for a little while, as a student, altered forever one's attitude to Nature. It was not that they gave us information, knowledge, facts. The syllabuses of their courses of study were nothing like so perfect as that of the smallest German polytechnic. And yet if a youth with a liking for physical science had gone to a German gymnasium to the age of 19, and had become a walking encyclopædia on leaving one's polytechnic at the age of 24, the course of that life-study would not have done for him as much good as was done by a month's contact with one of these men. People call it personal magnetism, and think there is something occult about it. In truth, they revealed to the student that he himself was a man, that mere learning was unimportant, that one's own observation of some common phenomenon might lead to important results unknown to the writers of books." Such men teach one "to see that the very commonest phenomenon has still to reveal important secrets to the understanding eye and brain, and that no man is a true student unless he is a discoverer." He is opposed to the study of Latin, and condemns the public school education in England. "What we want to see is that a boy of 15 shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the student of natural science. Such a boy is fit to begin any ordinary profession." To be versed in experimental mathematics means that "he will use logarithms, and mere multiplication and division will be a joy to him; he will have a working power with algebra and sines and cosines; he will be able to tackle at once any curious new problem which can be solved by squared paper, and he will have no fear of the symbols of the infinitesimal calculus. . . . To many men it will seem absurd that a real working knowledge of what is usually called higher mathematics, accompanied by mental training, can be given to the average boy. In the same way it seemed absurd 500 years ago that power to read and write and cipher could be given to everybody. These general beliefs of ours are very wonderful."—*Lond. Elec.*, September 12.

New Book.

The Generators at the Paris Exhibition of 1900. By C. F. Guilbert. Paris: C. Naud. 766 pages, 615 illustrations, 118 plates, and 20 separate tables. Price, 30 francs.

The great work before us is a monument of able and patient labor, and a perfect mine of valuable information. The fact that almost all the prominent manufacturers in the world exhibited some of their generators and motors at the Paris Exposition, lends this work special interest and importance. The clear illustrations and the accurate drawings in connection with reliable experimental results, the addition of a chapter on wave-shapes taken by a Blondel oscillograph, and finally the tables summing up in a clear and well-arranged manner the most important electrical data, these features give a unique appearance to M. Guilbert's work. The expert, the teacher, and the student will profit by, and enjoy, a work of this nature, as it is of the greatest interest to see how different engineers have solved the same problems. Furthermore, Mr. Guilbert's work embodies descriptions of the latest inventions made in the field of generators, motors, and transformers, and to the American reader this will be of great value.

The work is divided into different chapters treating successively of revolving field alternators, which the author distinguishes from the induction type alternators by calling their fields "discontinuous," while the fields in the induction type generator are called "continuous." Next the induction type compounded alternators of which Boucherôt's machine with exciter with a sine winding is described at length. Next inductor machines are illustrated and described. The second part of the work is occupied with the description of stationary and rotary transformers, and the third part is devoted to direct-current machines.

The whole field of the present status of the art of dynamo design is laid before the reader in this work, and the labor of reading it is greatly eased by excellent type and illustrations, while the difficulty of the French text is to a great extent done away with by M. Guilbert giving the head lines of chapters and the descriptions on the illustrations side by side in French, English and German.

Directory of Electrical Societies, Etc.

American Institute of Electrical Engineers, Secretary, Ralph W. Pope, 95 Liberty Street, New York. Next meeting Oct. 24, paper by C. P. Matthews on "An Integrating Photometer for Glow Lamp and Sources of Like Intensity."

American Street Railway Association, Secretary, T. C. Penington, 2020 State Street, Chicago, Ill. Next meeting, Detroit, Mich., Oct. 8, 9 and 10, 1902.

International Association of Municipal Electricians, Secretary, Frank P. Foster, Corning, N. Y. Next meeting, Richmond, Va., Oct. 7, 8 and 9, 1902.

National Electric Light Association, Secretary, James B. Cahoon, 136 Liberty Street, New York. Next meeting, Chicago, May, 1903.

Northwestern Electrical Association, Secretary, Thos. R. Mercein, Milwaukee, Wis.

Ohio Electric Light Association, Secretary, J. H. Perkins, Youngstown, Ohio. Next meeting, Columbus, Oct. 14, 15 and 16, 1902.

A New Industrial Centre at Trafford City, Pa.

The great growth of the affiliated Westinghouse industries was recently signalized by the creation of a new city and the building of another Westinghouse manufacturing plant. The new industrial center is located about 17 miles east of Pittsburg, on the Pennsylvania Railroad, and is to be known as Trafford City. Extensive factory sites have been laid out here to provide for the overflow of the several Westinghouse industries, a number of which have already used up all the available building room at their present locations and are still pressed for space. The first of the Westinghouse companies to erect buildings in the new city is the Westinghouse Foundry Company, which is at present putting up an extensive and model foundry plant and pattern shop. This addition is necessitated by the rapidly increasing business of the Westinghouse Machine Company, especially in connection with very large steam and gas engines and steam turbines.

The new town is connected with Pittsburg by the Pennsylvania Railroad, over which there are 46 local passenger trains going each way daily, and reaching the center of the city in from 25 to 35 minutes. In addition a trolley line has been built, connecting with the Pittsburg Railways Company's line at Wilmerding, 2½ miles distant. This street railway passes over the steel viaduct into Trafford City and forms a loop through the principal streets.

The new foundry and pattern shop of the Westinghouse Foundry Company are located at the extreme southern portion of the factory site, and near the steel viaduct mentioned above. The pattern shop and storage building, which has already progressed well towards completion, is a steel and brick structure, 605 feet long and 80 feet wide, with a height to the eaves of the roof of 47 feet. The pattern shop occupies 160 feet at one end of this building. It is divided into two floors, the second floor being suspended from the roof trusses in order that the first story may be entirely free from columns, thus providing ample space for handling the largest patterns. The remaining 447 feet of the building is to be used for the storage of patterns and has three floors, the two upper floors being supported on steel columns, and the entire space being divided by interior fire walls into three separate compartments.

The foundry building is 611 feet 8 inches long and 184 feet 3 inches wide outside of the brick walls, which are 36 feet high at the eaves and 80 feet at the peak. As in the case of the pattern shop, the foundations are built of concrete, and the superstructure of steel and brick. The foundry is divided transversely into three bays, the

center bay being 80 feet 3 inches wide between centers of columns, runways being provided for traveling cranes of 80-foot span and 150-tons lifting capacity. The cranes will be electrically driven. The two side bays are each 50 feet 6 inches wide from center to center of columns and are provided with runways for traveling cranes of 47 feet 2½ inches span and 50-tons lifting capacity. At one side of the foundry building runways are provided for yard traveling cranes of 100-foot span, and a lifting capacity of 75 tons.

The plans for the buildings were prepared under the supervision of the Westinghouse Machine Company. The Security Investment Company, of Pittsburg, Pa., is the financial agent and general contractor for the entire works, and Messrs. James Stewart & Co., of St. Louis, Mo., and Pittsburg, Pa., are the managers of construction. The Real Estate Trust Company, of Pittsburg, Pa., successfully handled the extensive sale of city lots adjoining the new works.

Electric Heating and Cooking.

The Prometheus Electric Company, 60 Reade Street, New York, is introducing in this country an electric heating system, which was first developed in Europe and has been in successful use in Germany for the past seven years. In Austria the well-known Siemens & Halske Company has introduced the system, and in Switzerland, England and France it is extensively used for domestic and commercial purposes. The Prometheus Electric Company has Americanized the apparatus in many of its details, and is now manufacturing a complete line of cooking utensils and heating apparatus, including chafing dishes, tea kettles, hot water boilers, coffee machines, hot water urns, plate warmers, broilers, stoves, laundry irons, laundry machines, pleating machines, curling irons, soldering irons, glue pots, street car heaters, radiators, sterilizers, medical appliances, motor rheostats, controlling devices, theatre dimmers, etc. The accompanying illustrations show some of these, Fig. 1 representing a melting pot and soldering iron; Fig. 2 a laundry iron; Fig. 3 a rheostat; Fig. 4 a car and stateroom heater, and Fig. 5 some cooking utensils.

FIG. 1.—MELTING POT AND SOLDERING IRON.

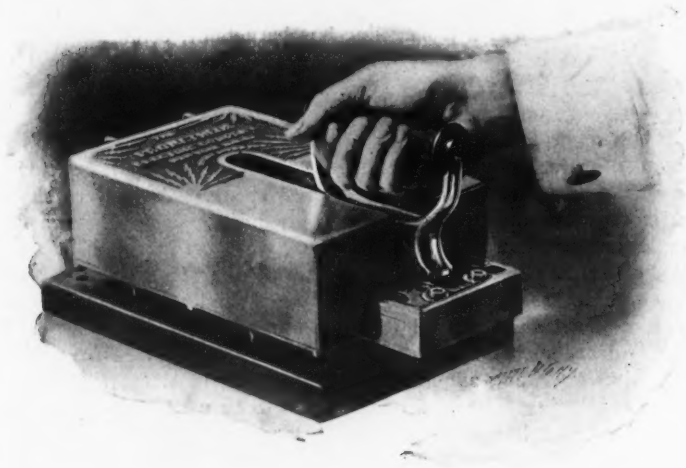


FIG. 2.—AUTOMATIC LAUNDRY IRON STAND.

In most, if not all, systems except the "Prometheus," the heating is effected by wire coils or ribbon conductors embedded in some insulating material, generally enamel. In the present system, however, no wires are used. The heating device itself consists of a strip of mica on which a layer of metal has been deposited, or more properly speaking, fired. This conducting strip is protected by another piece of mica, and the whole is enclosed in a metallic casing.

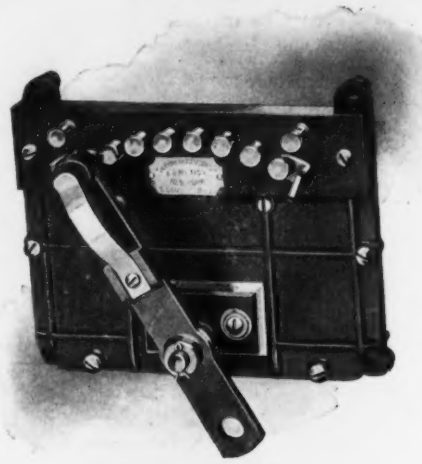


FIG. 3.—RHEOSTAT.

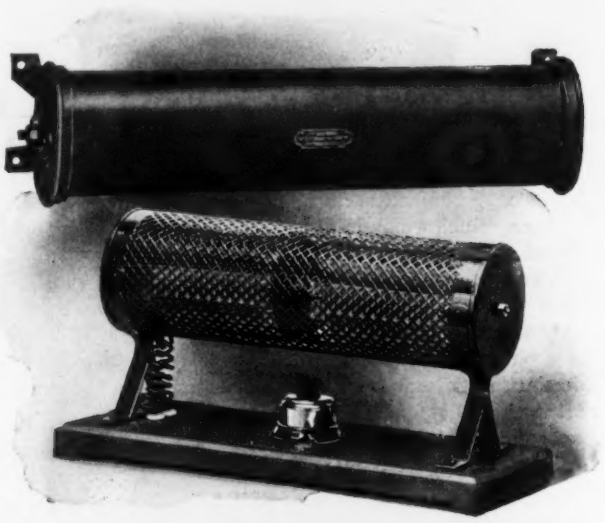


FIG. 4.—CAR AND STATE ROOM HEATERS.

This unit or "heating element" can be painted to any desired resistance. The paint is an alloy composed of non-oxidizable metals, insuring the element's life. The element may be either straight or circular, according to its usage, and may be inserted into or removed from a piece of apparatus with the greatest ease by an unskilled person in case of a break-down, an advantage heretofore denied by any other known method.

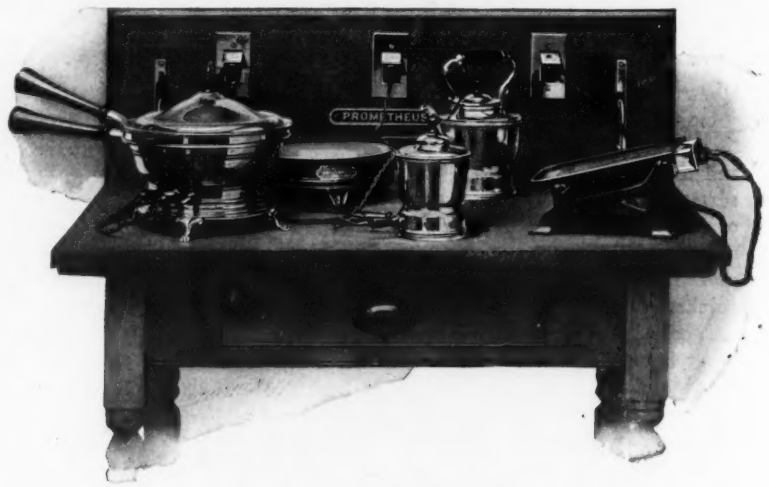


FIG. 5.—COOKING EQUIPMENT.

As stated above, in this system the utensils themselves are equipped with the heater, thus dispensing with a stove, which means not alone the purchase of a single piece of apparatus, say a pot or chafing dish, instead of a pot or chafing dish and stove on which to place it; but the inefficiency of the latter device is obliterated. It is claimed that by actual tests 87 per cent. of the heat sent into a utensil is utilized therein for the heating of food. This may be illustrated by holding in the hand a pot in which water is boiling, the escape of heat being so slight that this can be done without discomfort.

S. K. C. Railway Motor.

We illustrate herewith a type of railway motor manufactured by the Stanley Electric Manufacturing Company, which is designed for city and suburban service and has a rating of 37½ horse-power, based on the usual shop test of 75 degrees F. rise at the expiration of one hour's run at full load. On account of the superior ventilation of the motor, however, the temperatures actually reached in service are considerably below those that might be expected in view of this rating.

The frame is approximately cylindrical in shape and is divided horizontally into two halves, which are held together by four bolts. On the side furthest from the axle there are two eye-bolts on the lower half which fit on hooks cast in the upper half. The lower half can be swung down by taking out the two bolts nearest the axle, leaving it hanging on the two eye-bolts and their hooks. If it is desired to remove the lower half entirely, all four bolts are removed and the lower frame dropped into the pit by suitable jack or tackle. The pole pieces are made up of soft laminated steel punchings, riveted together and attached to the frame by bolts passing through the frame and tapped into a large rivet in the center of the pole piece. Each pole piece has a flare or offset at the armature end which, besides holding the field coil in place, also effects that distribution of the magnetic flux entering the armature which results in the best commutation.

The armature bearings are babbit-lined cast-iron shells. These are of ample size, the commutator bearing being 6⅛ inches long and the pinion bearing 7¾ inches, so that the wear of bearings which has been such a frequent source of trouble is here reduced to a minimum. They are held in place by bearing caps bolted to grease boxes cast in the upper half of the frame. The caps themselves are entirely separated from the lower half of the frame, so that the lower half may be removed, leaving the armature supported by the upper half. If desired, however, the caps may be removed before the frame bolts and the armature lowered with the lower

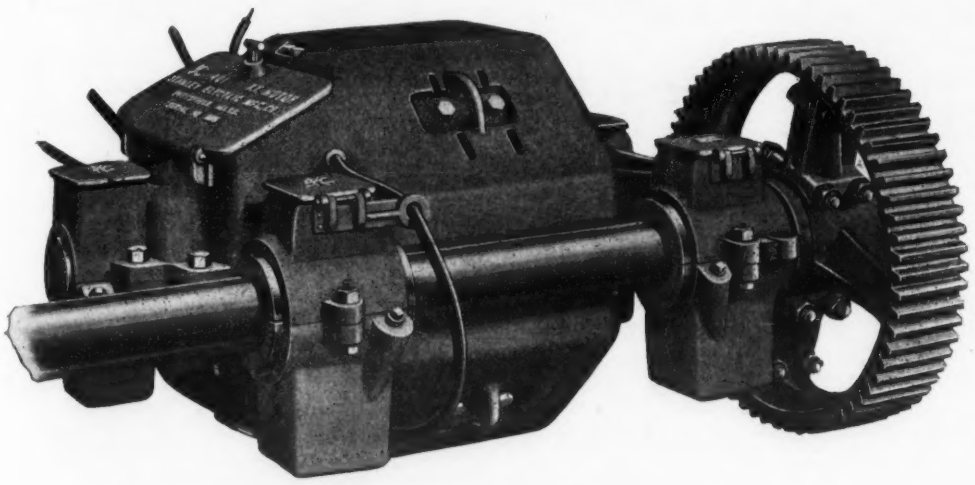


FIG. 1.—RAILWAY MOTOR CLOSED.

half of the frame. The caps are deep and hollow, furnishing ample oil cellars; and the bearings are kept lubricated by wicks bearing against the shaft. Grease boxes fitted with spring-closed covers are cast in the upper half of the frame and project over the bearings, furnishing an additional source of lubrication in case the oil runs out or the bearing begins to heat from other causes.

A space is left between the bearing cap and the frame, through which projects the oil guard on the armature shaft. Any oil escaping from the bearing is thus thrown outside of the motor and prevented from reaching or injuring the field or armature. The axle bearings resemble the armature bearings in their general construction.

The field coils are wound of square wire thoroughly insulated.

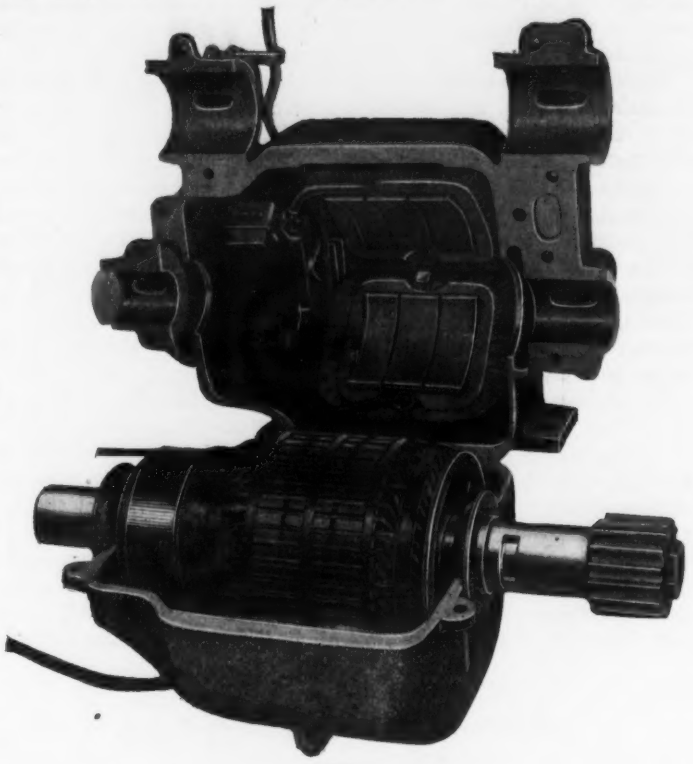


FIG. 2.—MOTOR OPEN.

Allowance of ample room in the frame casting enables a flat coil to be used, so that it is not necessary to bind the wire after it is removed from the form on which it is wound. The method of bringing out the terminals of the field coils is a feature which will be appreciated by those who have had experience in the repairing of street railway motors. The inner end of each coil is attached to a flat flexible copper strip which is brought out through the insulation, and the strips from the several coils are clamped together. The outer end of each coil is attached to a rubber-covered flexible wire several feet in length. These wires are brought through appropriate holes in the frame and are attached to the car wiring on the outside. The removes the danger of broken field wires at the terminals inside of the motor and makes it impossible for a repair man in replacing the coils to connect them in wrong order.

The coils after winding are dried in an oven, and while hot dipped in an insulating compound which fills the spaces between the wires and prevents the entrance of oil or moisture. The coils are then wrapped in layers or rope-paper, mica and tape, with leatheroid protection where the is a liability or chafing, and are finally thoroughly japanned and baked. The experience of the Stanley Company in the insulation of high-voltage coils is applied and lends assurance of the very best results in insulation of both field and armature coils.

The armature is unusually well ventilated. Large ducts parallel to the shaft allow the air to enter the body of the armature; and ventilating ducts perpendicular to the shaft allow the heat to escape from the interior of the iron. The magnetic densities of armature core and teeth are so proportioned as to ensure good commutation at heavy overloads, and the ample ventilation protects the insulation from injury by reason of these overloads. The armature end cast-

ing projects above the level of the coils so as to protect the end windings from injury. This casting being well cored out and well ventilated, is light and allows ample access of air to the windings. The armature coils are form-wound, dipped and thoroughly insulated with oiled linen and tape. The band wires holding the coils in place lie in grooves below the general surface of the armature, so that even if the bearings wear down, the face of the iron protects the armature bands from injury and thereby avoids a source of trouble frequently experienced in earlier types of motors.

The commutator bars are clamped together in a jig with micanite insulation between, and baked to soften or remove the shellac or other cementing material. The clamping screws are then tightened and the bars drawn solidly together. The ends are then turned to gauge and the insulating heads and end clamps fitted into place, after which it is again baked and the end clamps set up and locked into position. A neat cover over the commutator permits inspection of the same and replacing of brushes. Another hand hole at the bottom of the motor allows inspection from below. This hole is fitted with a ventilated cover filled with a sponge, which prevents the entrance of dust, but allows any water in the bottom of the motor to escape.

The motor is not water-tight in the sense that the entrance of water into its interior is absolutely prevented. The object has been to design a well-ventilated motor from which the heat from the interior, as well as any water, can readily escape. There are ventilating spaces under the cover of the motor, as well as at the opposite end, through which the air can enter the armature body to be thrown out through the perpendicular ventilating ducts in the armature. Ventilating ducts are also provided in the pole pieces, corresponding to those in the armature, an arrangement which results in a very free circulation of air in the interior of the motor.

New Type of Enclosed Arc Lamp.

A new type of arc lamp has been brought out by the Dayton Fan & Motor Company, Dayton, Ohio, in which, while the multiple system of gas chambers remain the same as in all types of "Belden" lamps, a new controlling mechanism has been introduced. Unlike in other lamps, the solenoid is pivoted to one end of a walking beam (instead of being rigidly connected to the lamp frame), and to the other end of the walking beam is pivoted the moveable carbon tube. The principal advantages claimed for this construction are that the weight of solenoid tends to balance the weight of movable carbon and tube; the solenoid has a double power when energized by a direct upward pull on the tube and downward pull on solenoid or opposite end of walking beam; any change in ampere-turns, due to changes at the arc, has a double effect of making the lamp very sensitive; and each ampere-turn having double power, allows the use of a very small solenoid, thus reducing the cost of manufacture and expense of repair parts.

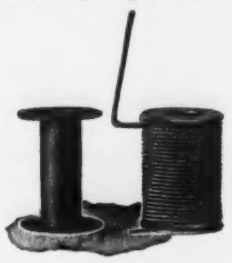


FIG. 5.—SPOOL AND SOLENOID.

FIG. 4.—DASHPOT.

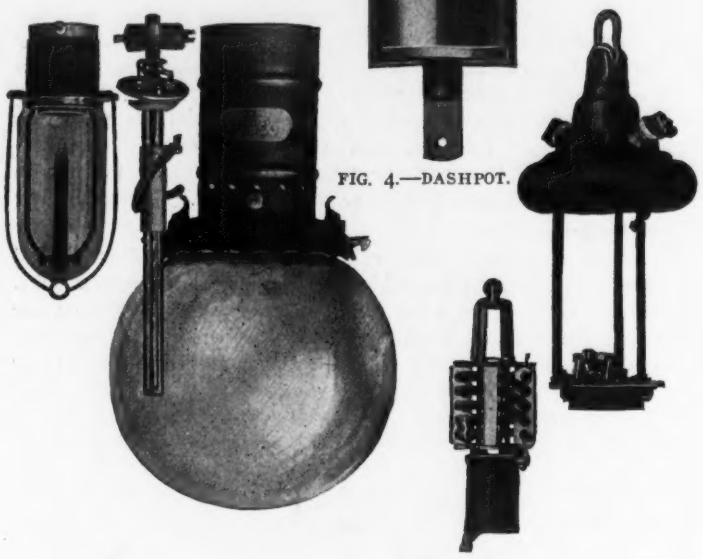


FIG. 3.—LAMP DISSEMBLED.

Fig. 1 is a view of the movable mechanism, which is pivoted to walking beam at *D*, the upper end being movably connected to lamp frame at *A*. Loops are brought out on the solenoid at *G F E* for ampere adjustment. A clamp is shown at *H* for voltage adjustment. This entire mechanism is assembled as one piece by the use of but two nuts, shown at *B*. Fig. 2 shows a lamp for outdoor use. This lamp is but 25 inches long over all; the body of case is 4½ inches

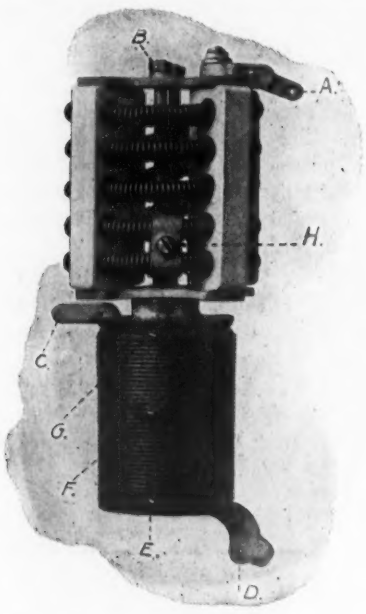


FIG. 1.—MOVABLE MECHANISM.

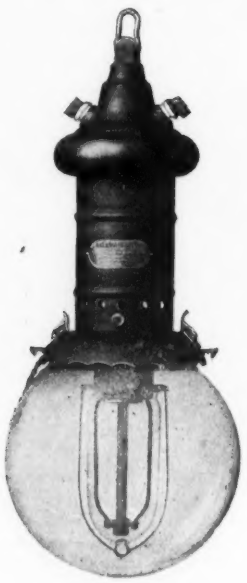
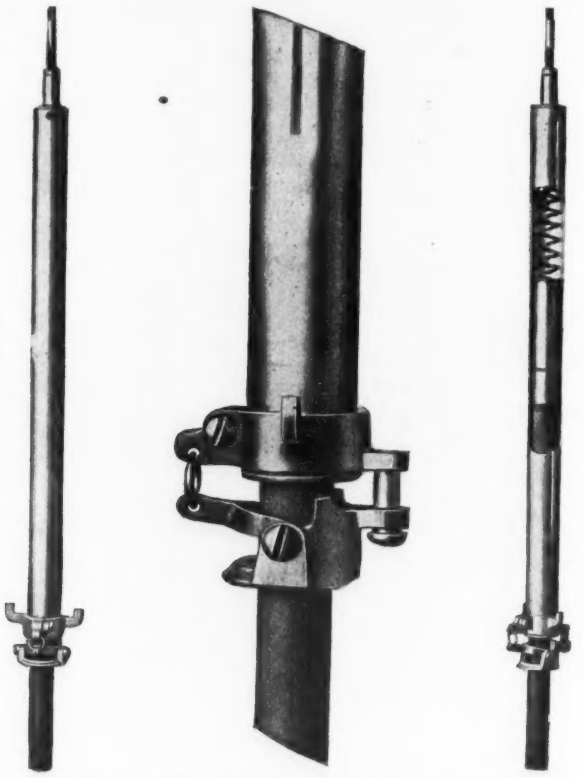


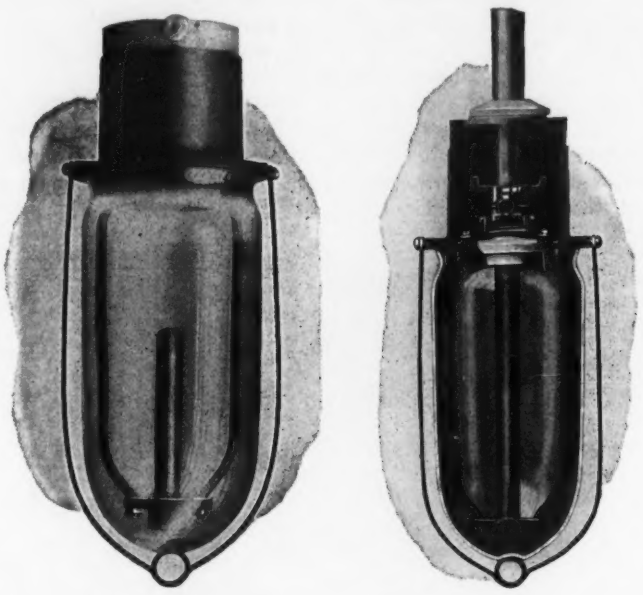
FIG. 2.—OUTDOOR LAMP.



FIGS. 6, 7 AND 8.—UPPER CARBON TUBE AND CLUTCH.

in diameter, the outer globe 11 inches in diameter, and the standard carbons 12 x ½ inches for 5 or 6 amperes, and 12 x ⅜ inches for three amperes.

Fig. 3 shows lamp disassembled into five sections, this requiring the removal of but two cotter pins and the breaking of but two connections, and can be accomplished in 30 seconds' time. Fig. 4 shows the dash pot. The valve in the top is a 3-16-inch ball, made of a special metal to prevent rust and corrosion. The plunger is made of a very fine high-grade graphite. The upper part or casing is



FIGS. 9 AND 10.—ENCLOSING GLOBE, SHOWING GAS CHAMBER.

pivoted to the movable mechanism and the plunger to the walking beam, which causes them to move in opposite directions, giving a very long, rapid movement, and controlling the lamp perfectly with a very loose fit, which obviates trouble from expansion and contraction common to snug-fitting dash pots. Fig. 5 shows the removable stamped metal spool and solenoid.

Figs. 6, 7 and 8 show upper carbon tube with the clutch at its lower end. In one view the tube is represented cut away to show

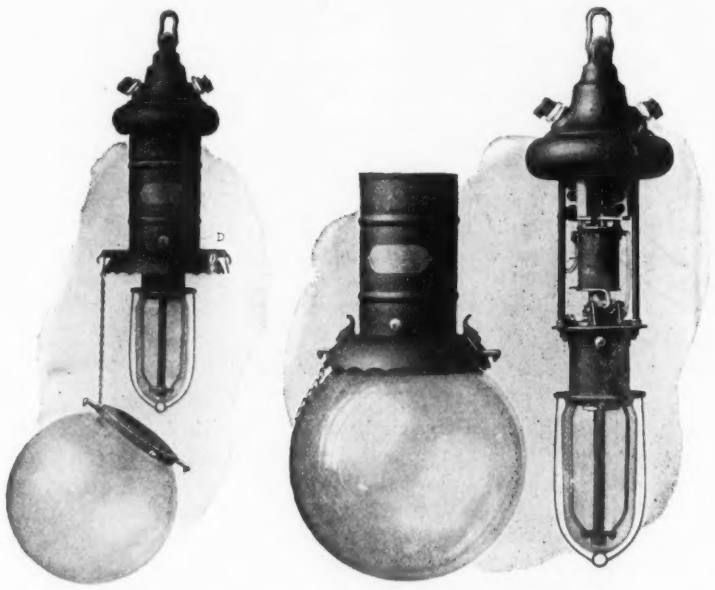


FIG. 11.—READY FOR TRIMMING. FIG. 12.—GLOBE AND CASE REMOVED.

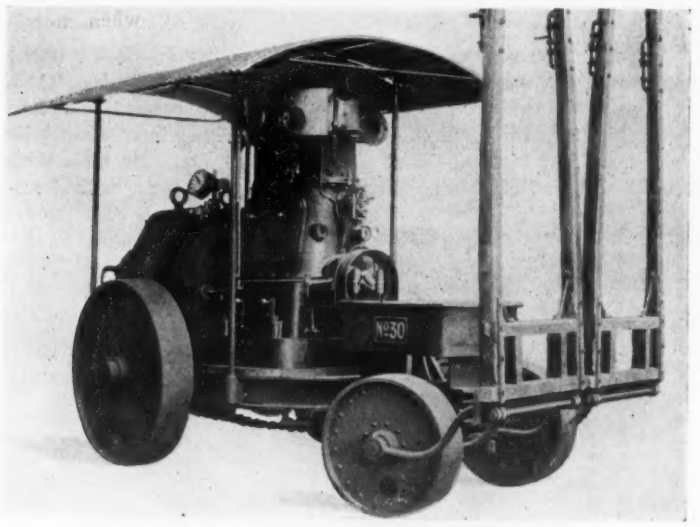
carbon clamp and flexible copper cable, which make a continuous electric path through lamp, without sliding contacts. One of the cuts shows a larger view of lower end of tube and clutch. The dog on left side of the clutch moves in the same direction of carbon when feeding, thus doing away with all friction. Figs. 9 and 10 represent arc enclosing globe and its holder, as well as the second or intermediate gas chamber. The sectional view shows the lava gas caps and clutch. It is claimed that the life of the carbon is greatly increased and the amount of deposit on globe decreased by this construction, as the gas has to pass through one gas cap, then through the second chamber, then through a second gas cap before escaping, and fresh air has to go through the same difficult path to get in, which keeps the combustion perfect. The inner globe holder is in keeping with the simplicity of construction throughout the entire lamp. The inner globe is the closed bottom type with large opening at the top for convenience of cleaning. Fig. 11 shows the outer globe lowered to trim, and Fig. 12 the globe and case removed as one piece, giving access to all moving parts.

Westinghouse Building in London.

The new Westinghouse building in London and its annex are well lighted. The building consists of seven floors and basement, each floor being designed for about 14 rooms. Three-wire service mains are brought into the building by the Charing Cross and Strand Electricity Supply Corporation, the supply being by continuous current at a pressure of 200 volts at the lamps. The main distribution board is of enamelled slate mounted in a massive teak frame, and provides for a separate circuit to each floor of the building. From this main board a separate circuit is run to each of the local distribution boards for supplying the various floors, where all the fuses are. All lamp circuits are run back direct to distribution board, no fuses being employed locally. The maximum number of incandescent lamps supplied from any sub-circuit is eight, and with few exceptions every lamp is furnished with a separate switch. The wiring is carried out in simplex brazed tube, all the tubes being fixed in position as the building work proceeded and the wires drawn in afterwards. The "Westinghouse" building contains upwards of 700 lights, together with a very elaborate and extensive system of electric bells for the tenants and service, gas fire points, speaking tubes, etc.

Portable Electric Lighting Plant.

To meet the need of an electric light plant which can be readily transported from place to place in military or naval service, the portable generating set shown in the accompanying illustration has been designed and manufactured by Messrs. W. H. Allen, Son & Co., Limited, Bedford, England. As will be seen the plant consists of one of this firm's high-speed, enclosed, compound, forced lubri-



PORTABLE ELECTRIC LIGHTING PLANT.

cation engines directly coupled to a six-pole dynamo of the same firm's manufacture and mounted on a transporting carriage.

The combination is capable of giving an output of 105 volts and 600 amperes when running at a speed of 400 r. p. m., steam being supplied at a pressure of 110 pounds at the engine stop-valve.

The particular plant shown is one of several which have been constructed by Messrs. Allen for the temporary lighting of any part of British dockyards. It is intended to be drawn by horses, the

carriage being rigidly built, and mounted on four wheels with broad treads and substantial axles, the whole being sufficiently stable to enable the plant to be transported over rough ground without injury to any part. The baseplate of the engine and dynamo is arranged so that it can be lifted off the carriage and bolted down on a fixed foundation if required. The carriage is covered with a roofing of galvanized corrugated iron, with water-proof curtains hanging from rails on the sides and ends. Boxes fitted with water-proof lids with padlocks and keys are provided for stowing tools, spare parts and stores. The weight of the complete plant is 8 tons 19 hundredweight.

It is somewhat interesting to record that one of these sets was lately fitted on board the royal yacht "Victoria and Albert." It was found that the engines and dynamos which were already there created too much vibration, and as the plant we illustrate is a silent working engine it was decided to fit this type on the yacht. The work was undertaken and completed in less than seven days, which is a record for the large amount of work necessary. The trials took place on Sunday, July 13th, and it was gratifying to all concerned to find that with the engine working at full load and delivering 60 kilowatts not a sound could be heard in the royal apartments. Stringent tests were made by the dockyard and other authorities to ascertain the vibration, and bowls of water were placed in various parts of the ship, but not a trace of vibration could be detected.

A Conduit Terminal Frame.

The cuts shown herewith illustrate an adjustable terminal frame for ending underground conduit in manholes. This frame serves not only to give the work a more finished and neater appearance, but allows a better arrangement of the cables, as they can be placed closer to the walls without kinking the lead sheath and without being damaged by sharp corners. The common practice in ending conduit in manholes has been to bring the ducts flush with the face

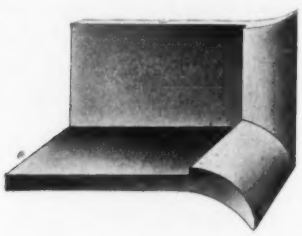


FIG. 1.—SECTION OF FRAME.

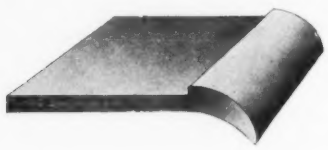


FIG. 2.—CORNER PIECE OF TERMINAL FRAME.

of the wall, thereby causing a sharp corner, which is encountered when drawing in cables and is liable to cut or scrape the lead cable sheath so as to cause serious injury.

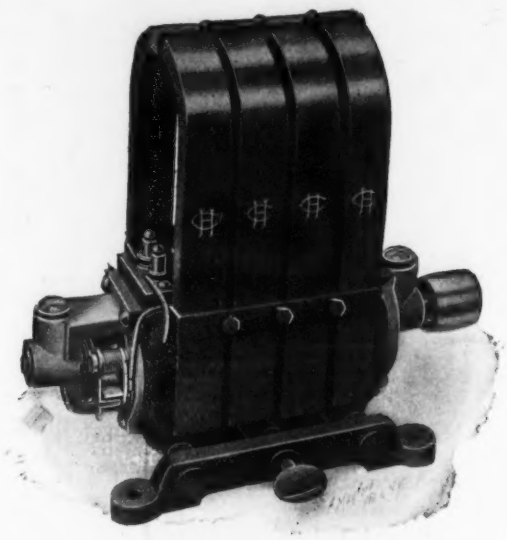
In shaping the cables to the walls a good arrangement cannot be obtained without kinking the sheath where the ducts are flush with the wall. The adjustable terminal frame seems to be a radical improvement over the old method, and being smooth and having no sharp edges or corners, offers no obstruction to the drawing in of cables. The frame is adjustable to a run of any number of ducts, and is one of the many specialties now being placed on the market by G. M. Gest, the well-known subway contractor of New York and Cincinnati, who has of late addressed his attention to subway physical problems with conspicuous success.

FIG. 3.—FINISHED MANHOLE, SHOWING CONDUIT TERMINAL.

Gas Engine Igniters.

The Holtzer-Cabot Electric Company, Boston, Mass., has supplemented its line of gas engine igniters with a larger size, a machine exceeding, it is said, in size and output anything else of the magneto type on the market. It weighs 30 lbs., and has a capacity momentarily of 50 watts, and continuously of about 25 watts.

The armature is of the slotted drum type, with laminated core. A compound winding is provided, which holds up the field under load, making possible a much greater output than could be obtained in a magneto of the usual construction. Particular attention is directed to the brush-holder, which is of the box type, with parallel



LARGE MAGNETO IGNITER.

feed, substantially constructed, allowing a brush of relatively large cross section to be used. A sliding base is provided with thumb screw for tightening the belt.

The machine is used to advantage with large engines and those whose "make-and-break" device is of such construction as to require a relatively large quantity of current. It combines the large output of the dynamo igniter with the advantages of the magneto type, namely, reversibility, independence of speed fluctuations, and ability to deliver a spark at a very low speed. These features also make the igniter useful in connection with automobile work, where the weight would not be a disadvantage.

Electric Glue Pot.

A useful application of electric heating is furnished in an electric glue pot manufactured by the United Electric Heating Company, of Detroit, Mich., which is shown in the accompanying illustration. That it may withstand the hardest usage, the pot is made of cast iron throughout. Among a number of new features embodied in the construction are an enclosed self-contained switch, slow-changing water level and the absence of surface contacts or connections. The heating coil is so placed that the glue will heat to the proper consistency very quickly without possibility of the pot burning out. The advantages claimed for this pot are that it will not dent or break, requires less refilling than the ordinary pot, heats more quickly, and is free from all danger of short-circuit or disarrangement of parts.

GLUE POT.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was very scarce during the week, 6 per cent. being the rate for all periods. Under the influence of the acute pressure in the money market stock prices declined throughout the list. The movement was attended by a great deal of liquidation by pools and large interests, and the market without becoming demoralized, was exceedingly weak. At the end of the week, however, a steadier tone asserted itself, although the market remained sensitive. The industrials were quiet, the United States Steel stocks selling off with the rest of the market and receiving support at the decline. Tractions also declined under the same influences, Brooklyn Rapid Transit closing at 66¼, being a net decline of 2 points. Metropolitan Street Railway, after having reached 146¾, closed at 142, a net loss of 3½ points, the lowest quotation on this stock being 140½. General Electric, Western Union and Westinghouse, common, suffered declines, but Westinghouse preferred made a net gain of 1¾ points, being the only exception in the electrical list. General Electric closed at 190, a net decline of 3 points; Western Union 94, a net loss of 1½ points, and Westinghouse common 223, a net loss of 2 points. The closing price of Westinghouse preferred was 225, which was the ruling figure throughout the week. The greatest loss in the electrical list was that of American Telephone and Telegraph, which amounted to 8 points; the closing price was 169, after having been 171. Other closing quotations were: American District Telegraph, 37, a net gain of 1¼ points, and American Telegraph and Cable, 94. Following are the closing quotations of September 30:

NEW YORK.

	Sept. 23.	Sept. 30.		Sept. 23.	Sept. 30.
American Tel. & Cable.	—	—	General Electric	191½	187
American Tel. & Tel.	171	—	Hudson River Tel.	—	—
American Dist. Tel.	—	—	Metropolitan St. Ry.	145	142¼
Brooklyn Rapid Transit	65½	66	N. E. Elec. Veh. Trns.	¼	¼
Commercial Cable	—	—	N. Y. & N. J. Tel.	—	157
Electric Boat	25	25	N. Y. E. V. T. Co.	—	13
Electric Boat pfd.	40	40	Tel. & Tel. Co. Am.	—	—
Electric Lead Reduc'n.	2½	3¼	Western Union Tel.	92	93⅞
Electric Vehicle	5¼	5¼	West. E. & M. Co.	223¼	218
Electric Vehicle pfd.	14	14	West. E. & M. Co. pfd.	—	—

BOSTON.

	Sept. 23.	Sept. 30.		Sept. 23.	Sept. 30.
American Tel. & Tel.	170	167	Western Tel. & Tel. pfd.	—	100
Cumberland Telephone	—	—	Mexican Telephone	2⅛	2⅛
Edison Elec. Illum.	—	277	New Eng. Telephone	140½	139
Erie Telephone	—	—	Westinghouse Elec.	109½	108
Western Tel. & Tel.	28¾	28	Westinghouse Elec. pfd.	108	108

PHILADELPHIA.

	Sept. 23.	Sept. 30.		Sept. 23.	Sept. 30.
American Railways	54½	52½	Phila. Traction	98¼	98
Elec. Storage Battery.	—	—	Phila. Electric	8¾	8⅞
Elec. Storage Bat'y pfd.	—	—	Pa. Elec. Vehicle	—	—
Elec. Co. of America.	10¼	10	Pa. Elec. Vehicle pfd.	—	—

CHICAGO.

	Sept. 23.	Sept. 30.		Sept. 23.	Sept. 30.
Central Union Tel.	—	—	National Carbon pfd.	103½	101
Chicago Edison	—	—	Northwest Elev. com.	—	36½
Chicago City Ry.	—	215	Union Traction	18⅞	17½
Chicago Tel. Co.	175	—	Union Traction pfd.	58*	48⅝
National Carbon	33	32			

* Asked.

TELEPHONE DEEDS OF TRUST.—At Wilmington, Del., on September 25, in the office of the Recorder of Deeds Josiah Marvel, attorney for the International Telephone Company, recorded a deed of trust for $1,000,000, to secure an issue of bonds amounting to $100,000,000, the greater part of which has been underwritten by capitalists in New York, Baltimore and Washington. The company expects to enter the telephone business as a rival of the present systems, and place the cost of telephone calls the same as the charge for mailing a letter. The International Telephone Company was incorporated through Mr. Marvel, on May 15 of this year, with a nominal capitalization of one million dollars. In a few days an amended certificate will be filed increasing the capital stock to $20,000,000, and the fees from it to the State of Delaware will be about $30,000. Of the $200,000,000 capital stock, it is understood that $170,000,000 of it has been subscribed for or underwritten. The officers of the company are: President, S. B. Rhinehart, a banker of Waynesboro, Pa.; treasurer, Ehlem B. Harrison, of Baltimore; secretary, Henry F. Fahey, of New York; assistant secretary, J. Miller Kenyon, of Washington.

CUBAN ELECTRIC RAILWAY.—At a meeting, held in New York a few days ago, the Cleveland, Youngstown, Chicago and New York capitalists who are interested in the building of an electric line in Cuba, organized the company as the Havana and Jaintos Railroad Company, with capital stock of $2,500,000. The stockholders elected the following directors: W. H. Whipple, New York; W. J. Hayes and L. W. Prior, Cleveland; C. S. Fairchild, New York; M. A. Devitt, Chicago; H. A. McCoy, Chicago; George F. Penhale, New York; Thomas Vaughan and Judge Mandelay, of Havana. The directors elected W. H. Whipple, president, and W. J. Hayes, vice-president. It was decided to commence construction work at once, and contracts were closed with Park & Hamilton, of Youngstown. The New York Security and Trust Company will act as financial agents. It is stated that President Palma and the Cuban cabinet have given assurances that the company will be fairly treated, as it is the desire to induce American capitalists to invest in Cuba.

VENANGO POWER AND TRACTION COMPANY is offering its first lien 5 per cent. gold bonds, of a total $1,000,000. The capital stock is the same amount. Daniel O'Day is one of the directors. Half of the issue has already been sold. The Venango Power and Traction Company is a consolidation of all the electric railways in Venango County, Pennsylvania, embracing the following properties: Citizens' Traction Company, Franklin Electric Railway Company, Oil City Street Railway Company, Oil City; Rouseville and Franklin Railway Company, Station Railway Company, which are operated as one continuous road of 32 miles, serving a population of 30,000, and the Citizens' Light and Power Company, which serves lighting to a population of 17,000. The company also owns Monarch Park. During the fiscal year ending July 1, 1902, the company earned a surplus over all fixed charges. Recent net earnings are in excess of twice the interest charges.

NEW YORK AND NEW JERSEY TELEPHONE.—The New York and New Jersey telephone directors have authorized an issue to stockholders at par of $3,125,000 in proportion to their present holdings. The company's present stock amounts to $9,375,000. Payment will be required, 40 per cent. November 1, 1902, 30 per cent. May 1, 1903, and 30 per cent. August 1, 1903. Stockholders, if they prefer, may pay in full November 1, at 101.50 per share. The object of this increase in stock is to provide for general development of the company's business in Long Island and New Jersey. The rights were quoted last week at 18 to 20.

MICHIGAN TROLLEYS.—A company will be formed with a capital of from $30,000,000 to $40,000,000 to amalgamate all electric lines in the lower peninsula, with the exception of Detroit United Railways and the Monroe & Toledo Company. It is said the new company may be formed within thirty days. Westinghouse interests, Hawkes, Angus and New York bankers are in the deal.

MICHIGAN TELEPHONE BONDS.—The Boston Stock Exchange has stricken from the list Michigan Telephone Company consolidated mortgage 5 per cent. bonds of 1929, and admitted in their place, upon the unlisted department, the certificates of deposit for the Michigan Telephone 5 per cent. bonds, issued by the Old Colony Trust Company, transfer agent.

OTIS ELEVATOR.—The stockholders have had the privilege of subscribing to the new $2,000,000 issue of preferred stock, at par, to the extent of one share for each ten shares of stock, preferred or common, held by them as of record on September 25. Subscriptions were to be paid on or before October 1.

AUGUSTA, GA., TROLLEYS.—It is stated that the Augusta street railway and electric lighting plant, owned principally by the Jarvis-Conklin Syndicate, has been bought by the North Augusta Electric and Improvement company, and will be merged with the Augusta-Aiken Railway.

BOSTON ELEVATED ISSUE.—The stockholders of the Boston Elevated Railway have taken practically the entire issue of 33,000 shares of new stock at $155 per share. A large part of the stock was absorbed by small stockholders.

UNITED RAILWAYS AND INVESTMENT.—Application has been made to the Stock Exchange to list $15,000,000 preferred stock and $10,000,000 common stock of the United Railways and Investment Company.

MACON (GA.) TROLLEYS.—It is announced that the merger of the three street railway lines of Macon, Ga., has been completed. The deal involves about $1,000,000.

DIVIDEND.—The directors of Central and South American Telegraph have declared a quarterly dividend of 1½ per cent., payable October 8.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports of the most favorable character as to trade and industry continue to be made to the mercantile agencies. Large yields of nearly all crops have been secured; jobbing trade activity is unabated, manufacturing industry in nearly all lines is running at full speed, retail demand is improving, and railway and water transportation interests are pushed to handle business offered. The only unfavorable feature in the situation is the growing tension exerted by the anthracite coal strike, which now finds cool weather almost here and industry in many lines threatened with interruptions because of the enhanced price of bituminous coal. Among the industrials, the feature of transcendent interest was the enormous demand, greatly in excess of the supply, for iron and steel in its cruder forms. Buying of foreign iron and steel is liberal, notwithstanding advices from the Central West that consumers find difficulty in utilizing some of that already imported. There is still a marked scarcity of steel plates, and a premium of $5.00 per ton is reported for the quick delivery of structural steel. Producers are crowded with orders, and the announcement is made that some orders for bridge material have been secured for delivery in 1904. Some large orders for rails in this country and Canada have been placed with German and English manufacturers, because of the inability of American mills to accept the business. Foreign coal, iron and steel have advanced as the result of American demand or inquiry. Among the other metals, copper is notably weaker in price. While consumers did not seem to care to enter the market to any large extent, producers on the other hand have not pressed sales. The quotations are 11⅝ @ 11¾c. for Lake, 11⅜ @ 11½c. for electrolytic in cakes, wire bars and ingots, 11⅛ @ 11¼. for cathodes, and 11⅜c. for casting copper. The business failures for the week ending September 25, as reported by *Bradstreet's*, numbered 172, as against 182 the week previous, and 197 the same week last year.

CROCKER-WHEELER CONVENTION.—The Crocker-Wheeler Company held at its works, at Ampere, N. J., on September 25th and 26th, its annual managers' convention. On the evening of the 25th, the annual banquet was held at the Engineers' Club. Those present were the officers of the company, Schuyler S. Wheeler, Gano S. Dunn, W. L. Brownell, Putnam A. Bates, C. N. Wheeler and F. V. Henshaw, and the branch managers, Samuel Russell, Jr., Julian Roe, J. Hally Craig, Louis P. Hall, W. H. Wissing, Francis B. DeGress, Henry J. Sage, William A. Doble and Harold Loras. At this dinner there were many interesting speeches made by the branch office managers, who came from the various districts throughout the entire United States. During the evening, Mr. Francis B. DeGress, of the company's New York office, having been in the service of the company longer than any of the other branch office managers, presented in their name to the general sales manager, Mr. Putnam A. Bates, a token of their esteem and an acknowledgement of his efforts in their behalf. To this Mr. Bates responded in his usual happy manner. The purpose of the convention is to bring all of the men closer together and give them an opportunity of comparing notes and planning methods for handling the largely increased business of the Company.

POWER IRRIGATION IN TEXAS.—A special dispatch from New Orleans, of September 23, says: Messrs. Wahl and Graybill came here yesterday from Houston, Tex., for the purpose of securing material for the purpose of construction and equipment of a large electrical plant for irrigation purposes on a tract of 10,000 acres of rice land near Houston. They have expended considerable money, and propose to erect a centrally located electric power plant on the plantation, which will operate a series of pumps in wells that are to be put down at proper intervals throughout the tract. A rice mill will be erected and operated with the same power, and the good-sized town near by will be lighted. In short, every portion of the motive power on the plantation will be furnished from the electric plant. They calculate that the cost of equiping the 10,000 acres with the electrical plant will be $250,000. This will be just $25 per acre. This estimate will include the rice mill, which will be entirely modern. They have made the water tests and are prepared to demonstrate that an inexhaustible supply of water underlies their land at a depth of from only 50 to 60 feet. "Our electrical pumping and milling plan will be far cheaper than the ordinary canal irrigation plan," said Mr. Wahl. "We shall never be at the mercy of the dry weather."

INDEPENDENT TELEPHONY.—A special dispatch from Philadelphia, of September 29, says: Charles E. Wilson, manager of the Keystone Telephone Company in this city, to-day confirmed the report that his company and other independent telephone systems had united in a traffic arrangement, by which they meant to begin a war on the Bell Telephone Company. He said further that it was the purpose of the allied independent interests to gain an entrance into New York, Boston, Chicago, Cincinnati and other cities. The line of battle has been drawn secretly during the last few months. New York will be the initial point of attack. From there a forced march will be made against Boston. "We shall have an independent system of telephones in operation in New York within a year," said one of those in command of the Keystone and its allied forces. "Boston and other large cities in the East and Middle West will soon be within our field of operations."

SHOSHONE FALLS POWER.—The Shoshone Falls Power & Irrigation Company is putting in a General Electric plant for the utilization of the Shoshone water power, including ten units of 1000-hp each run by De Remer turbines. There will be 180 miles of circuit, and 20 large transformers. Motors are to be installed for pumping and other purposes, and the company proposes to furnish electric light and power to all the towns between Red Cliff and Grand Junction, Colo. A granite power house is being built. The capital stock of the company is $500,000 and the officers are: J. R. De Remer, president and manager; Elmer E. Lucas, secretary; M. H. Dean, treasurer; C. W. Darrow, counsel; H. J. Holmes, first vice-president; W. Cardnell, second vice-president. It is estimated that 20,000-hp. can be obtained from the falls.

THE SOUTHERN PACIFIC RAILWAY COMPANY, in conjunction with the Rock Island, has adopted the Consolidated "Axle Light" system of electric lights and fans for electrically lighting and ventilating all the new cars to constitute the Golden State Limited, which goes into service between Chicago and California on November 1. This is the same system of electric car lighting that is used on the Twentieth Century Limited of the New York Central & Lake Shore, the Pennsylvania Limited and on the best trains of many other leading railway lines, as well as on all private Pullman cars.

PASS & SEYMOUR, incorporated, of Solvay, N. Y., whose New York City address has hitherto been 23 Dey Street, have moved to more extensive premises at 34 Dey Street. D. Brewster Hall, formerly in charge of the sales department of the factory territory, comprising 15 states, will be in charge of the new offices. It is intended to make a serious bid for export trade. F. M. Hawkins, who has heretofore represented the Pass & Seymour people in New York City, will now confine his attention to the interests of the Crouse-Hinds Electric Company.

EQUIPMENT FOR NATAL RAILWAY SHOPS.—The South African General Electric Company, which concern looks after the interests of the General Electric Company in that territory, has been awarded an important contract for the electrical equipment of the new Natal Government railway machine shops. The contract calls for the installation of no less than 119 motors, varying in size from ⅛-hp to 15-hp; six dynamos of 300-hp each; three electric cranes; six electric capstans, etc.

THE LOCAL SUPPLY DEALERS' ASSOCIATION, of Philadelphia, will hold a banquet Tuesday evening, October 7, at the Hotel Walton. This fact is significant, since it is another indication of the harmony prevailing in that body. All of the members are expected to be present, and a very enjoyable evening is anticipated. The committee of arrangements for the occasion consists of Messrs. T. L. Townsend and Frank H. Stewart.

ROSARIO ELECTRIC TRACTION PROJECT.—A company is reputed to be under formation by capitalists in Rosario, for the purpose of constructing an electric traction system, to operate from that South American city towards the north of the Oeste Santafecino line, passing by Juarez Celman station and reaching Elisa station, on the Central Railway line. The length of the line would be about eight miles.

SWITCHBOARD CONTRACTS.—The contract for a seven-panel, alternating switchboard for the Poughkeepsie (N. Y.) Light, Heat and Power Company has been awarded to S. B. Condit, Jr., & Co., Boston. Mr. Condit states for his firm that they have during this year been awarded the contracts for a majority of the large alternating, high-potential switchboards built in the East.

MEXICAN WATER-POWER PROJECT.—Still another Mexican water-power project is heard of. It is proposed to construct a hydraulic plant on the Jalacingo River, located in the Canton of Jalacingo, State of Vera Cruz. Some 50,000 liters of water will be utilized per second. Andres Lefebre, of Vera Cruz, is primarily interested in the scheme.

THE MOSCOW ELECTRIC LIGHT AND POWER COMPANY, Moscow, Idaho, has just installed a 150-hp Ball tandem-compound engine and 60-kw Stanley alternator, thus doubling the capacity of the plant. Mr. E. S. Aldrich is manager of the company, and reports business increasing very rapidly.

STEEL FOR SYDNEY POWER STATION.—The American Bridge Company, 100 Broadway, New York, has just made shipment of the last lot of structural material, which is to be utilized in the erection of the central power station of the Sydney city and suburban tramways, New South Wales.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical material from the port of New York for the week ended September 20: Argentine Republic—46 pkgs. material, $1,209. Antwerp—4 pkgs. machinery, $290; 22 pkgs. material, $1,471. Barcelona—24 pkgs. machinery, $3,000. Bremen—2 pkgs. material, $107. British West Indies—9 pkgs. material, $399. Brazil—76 pkgs. material, $1,321; 48 pkgs. machinery, $3,300. British East Indies—23 pkgs. material, $902. British Possessions in Africa—14 pkgs. machinery, $3,248; 24 pkgs. material, $463. British Australia—30 pkgs. machinery, $4,223; 199 pkgs. material, $5,002. Cuba—1 pkg. machinery, $238; 73 pkgs. material, $1,233. Central America—24 pkgs. material, $993. Copenhagen—1 pkg. material, $12; 4 pkgs. machinery, $470. Dutch West Indies—4 pkgs. material, $57. Dutch Guiana—4 pkgs. material, $200. Florence—1 pkg. machinery,, $60. Glasgow—91 pkgs. machinery, $4,205. Genoa—31 pkgs. material, $354. Havre—9 pkgs. machinery, $465. Hamburg—6 pkgs. machinery, $336; 18 pkgs. machinery, $1,700. Hayti—5 pkgs. material, $56. Liverpool—203 pkgs. machinery, $21,168; 32 pkgs. material, $1,756. London—16 pkgs. machinery, $1,442; 318 pkgs. material, $8,905. Mexico—36 pkgs. material, $414; 5 pkgs. machinery, $860. Manchester—5 pkgs. machinery, $750. Nova Scotia—7 pkgs. material, $69; 10 pkgs. machinery, $864. Newcastle—6 pkgs. machinery, $1,100. New Zealand—1 pkg. machinery, $113; 3 pkgs. material, $87. Portuguese Possessions in Africa—17 pkgs. machinery, $813; 13 pkgs. material, $150. Peru—2 pkgs. material, $44. U. S. Colombia—70 pkgs. machinery, $6,280. Venezuela—10 pkgs. material, $784. The following are the exports of electrical material from the port of New York for the week ended September 27: Argentine Republic—59 pkgs. machinery, $9,109; 158 pkgs. material, $4,222. Antwerp—19 pkgs. material, $1,943; 2 pkgs. machinery, $450. Amsterdam—4 pkgs. machinery, $150. British West Indies—5 pkgs. material, $153. Brazil—80 pkgs. material, $4,976; 5 pkgs. machinery, $405. British Possessions in Africa—33 pkgs. machinery, $530; 217 pkgs. material, $9,509. British Guiana—8 pkgs. material, $165. Bristol—6 pkgs. machinery, $396. British East Indies—38 pkgs. machinery, $3,085; 11 pkgs. material, $821. Belfast—3 pkgs. material, $158. British Possessions, all others—1 pkg. material, $20. Berlin—1 pkg. material, $40. Bilboa—7 pkgs. material, $100. Cuba—249 pkgs. material, $894. Colchester—6 pkgs. material, $383. Copenhagen—1 pkg. material, $15. Chili—7 pkgs. material, $110. Dutch West Indies—3 pkgs. material, $64. Glasgow—6 pkgs. material, $309; 13 pkgs. machinery, $342. Genoa—58 pkgs. material, $975. Hamburg—4 pkgs. machinery, $270; 44 pkgs. material, $1,150. Hong Kong—11 pkgs. material, $76. Havre—82 pkgs. material, $1,748; 1 pkg. machinery, $75. Hayti—2 pkgs. material, $31. Japan—17 pkgs. machinery, $2,640; 20 pkgs. material, $1,278. Liverpool—174 pkgs. machinery, $10,250; 10 pkgs. material, $1,343. London—38 pkgs. machinery, $2,631; 172 pkgs. material, $6,196. Mexico—67 pkgs. material, $1,500; 7 pkgs. machinery, $237. Marseilles—1 pkg. machinery, $33. Manchester—1 pkg. material, $30; 190 pkgs. machinery, $29,962. Milan—1 pkg. material, $45. Madrid—1 pkg. material, $256. Newfoundland—1 pkg. material, $14. Nova Scotia—11 pkgs. material, $329. Peru—6 pkgs. material, $255. Philippine Islands—32 pkgs. machinery, $2,500; 96 pkgs. material, $4,127. Southampton—22 pkgs. machinery, $1,500; 1 pkg. material, $60. San Domingo—15 pkgs. material, $322. Turin—4 pkgs. material, $33. Uruguay—6 pkgs. material, $162. U. S. Colombia—3 pkgs. material, $222; 21 pkgs. machinery, $7,500. Vienna—36 pkgs. material, $3,019.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., advise us that the demand for electric cranes and hoists remains very satisfactory. They state that buyers are now more inclined to specify hoisting apparatus better conforming to standard designs, while the average capacity per crane appears somewhat less, yet this seems accounted for through a much more general demand. They quote recent sales as follows: Davenport Foundry and Machine Company, Davenport, Ia., one 5-ton crane; Alan Wood Iron and Steel Company, Conshocken, Pa., one 13-ton crane; Smeeth Copper and Bronze Co., Chicago, one 10-ton crane; Copper Queen Consolidated Mining Company, Bisbee, Ariz., three 10-ton cranes; American Sheet Steel Co., Cambridge, Ohio, one 30-ton crane, with 5-ton auxiliary hoist; International Harvester Company, Deering Division, Chicago, two special 5-ton hoists; Vulcan Crucible Steel Company, Alliquippa, Pa., one 15-ton crane with 3-ton auxiliary hoist; American Sheet Steel Company, McKeesport, Pa., one 30-ton crane with 5-ton auxiliary hoist and one 10-ton crane; Greenslade Foundry Company, Milwaukee, one 15-ton crane; American Foundry and Construction Company, Pittsburg, one 3-ton crane; Reading Iron Company, Reading, Pa., one 10-ton crane; Canonsburg Steel and Iron Works, Canonsburg, Pa., one 25-ton crane with 5-ton auxiliary hoist; The Holthoff Machinery Company, Cudahy, Wis., one 3-ton hoist; Allis-Chalmers Company, Milwaukee, for Sanitary District of Chicago, one 15-ton crane; The McConway & Torley Company, Pittsburg, Pa., one 2-ton crane; Brown Corliss Engine Company, Corliss, Wis., one 30-ton crane with 5-ton auxiliary hoist; Gisholt Machine Company, Madison, Wis., one 10-ton crane; The Milwaukee Electric Railway and Light Company, Milwaukee, one 5-ton special hoist; The Standard Steel Works, Burnham, Mifflin Company, Pa., one 10-ton crane; Christensen Engineering Company., Milwaukee, two 10-ton cranes; Hanson & Tunelius, Chicago, one 1½-ton hoist-crane; Sterritt-Thomas Foundry Company, Pittsburg, one 10-ton crane; The Elyria Iron and Steel Company, Elyria, Ohio, one 15-ton crane.

VOUGHT-BERGER NEW TELEPHONE CONTRACTS.—The Vought-Berger Company, of La Crosse, Wis., has just moved into a new large manufacturing plant, occupying three buildings, with a floor space of 20,000 square feet, making its factory one of the largest of its kind in the country. Mr. D. T. Foley, formerly superintendent and purchasing agent of Western Telephone Construction Company, has recently accepted a similar position in the company. Among switchboards and complete exchange equipment recently sold by the concern are: Western Wisconsin Telephone Company, Arcadia, Wis.; Kiester Telephone Company, Kiester, Minn.; Alexander Telephone Company, Alexander, Ia.; La Crosse Telephone Company (toll board); Peoples' Telephone Company, Houston, Minn.; Redwood County Rural Telephone Company, Redwood Falls, Minn.; Walnut Grove Telephone Association, Walnut Grove, Minn.; Farmers and Merchants Mutual Telephone Company, for Le Sueur and Rush River, Minn.; Harris-Jewell Telephone Company (Pendant telephones used exclusively), Coon Rapids, Ia.; Victor Mutual Telephone Company, Harvey, Ia.; Havelock Telephone Company, Havelock, Ia.; Davis Telephone Company, Goodwater, Ala., and the Golden Rod Telephone Company, for both Mead and Ceresco, Neb.

THE OTIS ELEVATOR COMPANY has recently closed a contract with the Subway Construction Company for an escalator, or moving stairway, to be installed at the Manhattan Street Station of the new rapid transit road. At this point, the "subway" crosses the Manhattan Valley on a viaduct, the tracks being about 40 feet above the level of the street. The escalator will carry passengers both up and down, the two tracks being arranged in the same vertical plane. The guaranteed carrying capacity of the device is 20,000 people per hour; 10,000 in each direction. A motor of 35 hp will be sufficient to operate the mechanism when working at its maximum capacity.

WATER POWER DEVELOPMENT IN THE SOUTH.—The Atlanta Water Power & Electric Company is carrying out a large water power project at a point on the Chattahoochee River, 13 miles from Atlanta, Ga. A dam, 50 feet high and 1,100 feet long, is being built at a cost of $450,000. The electric generating equipment will consist of seven 1,500-kw. Westinghouse generators, to be driven by turbines of the S. Morgan Smith Company, of York, Pa., which concern has the contract for the entire hydraulic equipment. It is expected that the plant will be completed in about 18 months.

ELECTRIC HEATING FOR STEAMSHIPS.—Mr. James I. Ayer, manager of the Simplex Electric Heating Company, reports that the new White Star liner, companion to the "Oceanic" and "Celtic," launched last month at Belfast, has all of its state rooms equipped with its "Enamel" state-room heaters, the same as were furnished for the "Celtic," for two large ships of the Cromwell Line, and for other vessels. The Simplex Company also equipped the "Oceanic" and the "Deutschland," but those had its American type heaters, not the enamel.

THE DICKEY-SUTTON CARBON COMPANY, incorporated and organized about the beginning of last month, at Lancaster, Ohio, It will be ready by December to make carbons for open and enclosed arcs; motor brushes, telephone carbons and carbon supplies. The officers of the company are: H. M. Sutton, president and treasurer; Edmund Dickey, vice-president and general manager; S. S. Wilson, secretary; Robert Dickey, superintendent. The above are directors, with Richard Sedgwick, of Richmond, Ind.

AN AUTO FOR THE DUCHESS.—The Duchess of Marlborough has purchased an electric victoria of American make from the Electric Vehicle Company, of Hartford, Conn. The vehicle is one of regular type, and was shipped last week to Blenheim, the ducal residence in England. Her grace will operate the automobile herself.

PAPER MILL POWER PLANT.—The new plant of the Millers Falls Paper Company, in New England, will be driven throughout electrically. Contract for the entire equipment, including generators, motors, arc and incandescent lamps, etc., has been placed with Sargent, Conant & Co., of Boston, Mass.

POWER PLANT FOR GOLDENDALE, WASH.—J. A. Cranston, the General Electric Company's manager at Portland, Ore., is, it is stated, preparing estimates for an electric power plant to supply Goldendale, Wash.

OTIS ELEVATORS.—During the month of August the New York office of the Otis Elevator Company closed contracts for 63 electric elevators.

General News.

THE TELEPHONE.

LOS ANGELES, CALIF.—The Home Telephone & Telegraph Company, with a capital stock of $3,000,000, has been incorporated. Directors: J. M. C. Marble, Thos. W. Phillips, H. W. Hellman and others. The company will have lines from San Diego to San Francisco by way of Los Angeles, Bakerfield and Fresno.

MANITOU, COLO.—The El Paso Telephone Company has applied for a franchise to conduct a telephone business in Manitou.

ORLANDO, FLA.—The Orlando City Council has granted a franchise to the Sanford Telephone Company to construct and operate a telephone line in this place.

WAYCROSS, GA.—The Southern Bell Telephone Company was given a twenty-year franchise by the city council and will put in a complete new system at once. The Bell Company recently purchased the local exchange, but was dissatisfied with the franchise.

TAYLORVILLE, ILL.—Dr. A. T. Bridges, of Stoughton, and Dr. R. E. Henshie, of Taylorville, have been granted a franchise for a telephone system here.

PEORIA, ILL.—The Citizens' Telephone Company has secured the right of way between East Peoria and Lacon and its line will be extended to the latter city.

ROCK ISLAND, ILL.—The telephone operators in the Rock Island and Moline exchanges of the Central Union Telephone Company struck recently, owing to failure to reach an agreement with the company on the scale of wages. The telephone service in both places was badly crippled as a result of the strike. The strikers are circulating petitions for signature among the business men demanding that the company settle the differences or remove its instruments from their premises.

CHICAGO, ILL.—The development of the telephone system in the farming sections is remarkable. Farmers in Illinois and Iowa are now connected by wire with Chicago, in many instances, and it is a common occurrence for them to talk daily with Chicago live stock commission merchants.

LAFAYETTE, IND.—The Pocket Telephone Company, of Lafayette, has been incorporated to manufacture pocket telephones and instruments for police and fire alarm service. Capital stock, $18,000. Directors: Evan Shelby, George D. Haywood and Charles A. Burnett, of Lafayette.

NEW CASTLE, IND.—The New Castle Independent Telephone Company has 170 telephones in working order and the entire plant will soon be completed. Five hundred feet more of cable is to be put up.

RIVERSIDE, IA.—The Iowa Telephone Company is building a line direct to Iowa City from here.

RICHMOND, KY.—Bids will be received in the near future for a telephone franchise in this place.

LOUISVILLE, KY.—The Cumberland Telephone and Telegraph Company has issued a statement of its business for the month of August, 1902, and the growth of the business is shown as follows: Number of subscribers August 1, 1902, 85,318. Net increase of subscribers for the month, 905. Total number of subscribers August 31, 1902, 86,223.

PITTSFIELD, MASS.—The New England Telephone Company will erect an exchange building on Pearl Street.

DORR, MICH.—A telephone line is being erected between this village and Moline. A line is also to be run from Moline to North Dorr, New Salem and Burnips Corners.

YPSILANTI, MICH.—Mayor Dawson will veto the Independent Telephone Company franchise as the result of investigating the telephone situation at Lansing and Jackson, where both Michigan and independent systems are in operation. He has come to the conclusion that it would be a mistake for Ypsilanti to have two systems.

ALMA, MICH.—The Michigan Telephone Construction Company has been organized here. The capital stock is $75,000, fully subscribed. The directors are W. A. Bahlke and G. S. Ward, of Alma, Fred R. Mossinger, of Stanton, and Hamlin J. Ward, of Big Rapids. The officers are W. A. Bahlke, president, and G. S. Ward, secretary and treasurer.

NORTHVILLE, MICH.—The annual meeting of the Northville Telephone Company was held recently and officers elected as follows: President, J. M. Burgess; vice-president, R. M. Johnson; secretary, R. H. Porter; treasurer, E. H. Lapham; directors: W. H. Yerkes, F. S. Neal, A. K. Carpenter, W. G. Yerkes and R. C. Yerkes. A fifteen per cent. dividend was declared and extensions of the lines ordered to make connection with Plymouth and east into Livonia.

DETROIT, MICH.—The State line service of the Oakland Telephone Company has gone into effect. The Oakland company is connected with the Owosso Telephone Company at Holly and through that company gets connection with practically all the western and central portion of the State. A reduction of the present rates of the Michigan company is announced. Connection with Detroit is now the greatest need to the independent system of Oakland County.

CHURCH HILL, MINN.—The Buffalo Lake Telephone Exchange is surveying a line to connect with Brookfield and Church Hill.

DAWSON, MO.—A mutual telephone company has been organized here.

KANSAS CITY, MO.—The Williamsburg Telephone Company, of Williamsburg, has been incorporated with a capital of $3,000.

KANSAS CITY, MO.—A stockholders' meeting of the Home Telephone Company has been called for Nov. 14, at which time it is proposed to increase the stock from $50,000 to $3,000,000. The intention of the managers is to sell bonds to the value of $1,000,000. Already something like $50,000 has been spent by the company in starting the plant.

SOUTH OMAHA, NEB.—The Interstate Independent Telephone Company has been incorporated, capital $100,000. Incorporators: A. A. Wright, Thos. Healy, L. C. Gibson and others.

ORD, NEB.—The Ord Independent Telephone Company has been incorporated with a capital of $10,000. Fred J. Bell is president; H. M. Davis, secretary; S. E. Bell, treasurer. Two hundred subscribers have already contracted for the service in Ord.

PINEVILLE, N. C.—S. L. Meachem, of Fort Mill, S. C., has received a franchise for a telephone system at this place.

BATH, N. Y.—The Century Telephone Company is extending its lines to this place from Corning.

CALEDONIA, N. Y.—The Inter-Ocean Telephone & Telegraph Company is building a line between this point and Avon.

ONEONTA, N. Y.—The Oneonta Telephone Company has been incorporated. Capital, $10,000. Directors: E. W. Elmore, Wm. H. Smith, F. J. Ives and others.

CAMBRIDGE, N. Y.—The Buskirks & South Cambridge Telephone Company has been incorporated, capital $400; directors: Chas. King, E. B. Chase and W. C. Chase, of Buskirks Bridge.

ALBANY, N. Y.—The Northwestern Telegraph and Stock Company, of Troy, has been incorporated to operate lines of telegraph and telephone between New York, Chicago, Philadelphia, St. Louis, San Francisco, Montreal and other cities: capital, $40,000. Directors: Michael J. Duffy, Peter Curley and Thomas Hendrickson, Troy.

MADISON, OHIO.—The Madison Telephone Company has decided to extend its lines in Lake, Geauga and Ashtabula Counties this fall.

BATAVIA, OHIO.—The Bell Telephone Company has reduced its rates in Clermont County, placing toll charges on an equal basis with Cincinnati subscribers.

WAUSEON, OHIO.—The Northwestern Telephone Company will add another section to its board in the near future. The company has more orders than can be taken care of with present facilities.

NORWALK, OHIO.—The Local Telephone Company has ordered material for a new line to be built from Monroeville to Morehead and will build another to Fitches Corners. A large number of farmers are subscribing to the service.

COLUMBUS, OHIO.—The Columbus Citizens Telephone Company has concluded a contract with the Automatic Electric Company of Chicago for the installation of an automatic system in the local exchange. The system will have an immediate capacity of 7,000 and an ultimate capacity of 19,000 main-line telephones. It is proposed, for a time at least, to operate a duplex system; the present system to be continued and operated until it is fully demonstrated that the automatic exchange in actual service will give satisfactory results. The new exchange at Dayton, owned largely by the Columbus interests, will also be equipped with the automatic system.

GARBER, OKLA.—The Oklahoma Rural & Municipal Telephone Company, capital stock $2,000, has been chartered. The directors are J. D. Carpenter, J. B. Morgan and W. Groneman, all of Garber.

ALTOONA, PA.—The Pennsylvania Telephone Company has completed the work of laying the conduit system, which involved the digging of 6,248 feet of trench, in which was laid 43,535 feet of terra cotta conduit and 1,162 feet of iron pipe, making a total of 44,787 feet, or 8.52 miles of pipe. This will accommodate twenty-eight cables of 200 pairs each, or a total of 11,200 wires. Twenty-two manholes were also put in.

HAMPTON, S. C.—A charter has been granted to the Hampton Telephone Company, of Hampton, which has a capital of $3,000. E. M. Peeples is secretary and treasurer.

SIOUX FALLS, S. D.—Connections have been established between Hurley and Parker on the new rural telephone line between those places. About a score of farmers will be placed in direct communication with their market points by the construction of the line.

DENTON, TEX.—The City Council has granted the Southwestern Telegraph and Telephone Company a franchise for a local telephone exchange.

FORT WORTH, TEX.—The Fort Worth Telephone Company has organized here. It is composed of Pennsylvania capitalists. R. A. Fuller is president. The capital stock is $304,000.

PARKERSBURG, W. VA.—The West Virginia Telephone Company is preparing plans for a new system here.

WELCH, W. VA.—The Welch-Williamson Telephone Company has been incorporated with $25,000 capital stock, by J. W. McLoren, J. A. Henchey, E. P. Rucker, W. S. Dangerfield and R. E. Hainer. It will construct a line from Welch to Williamson.

TACOMA, WASH.—The Northwest Telephone & Telegraph Company is preparing to continue the building of its lines through western Washington.

DELTON, WIS.—M. L. Reynolds is building a telephone line from Dellona to Delton.

MILWAUKEE, WIS.—The Richfield, Menomonee Falls and Holy Hill Telephone Company, Richfield, Washington County, has been incorporated; capital stock, $1,000. Incorporators: Henry H. Huld and Bertha M. Zaun.

MILWAUKEE, WIS.—The Wisconsin Telephone Company is erecting a new exchange on Oakland Ave. in this city, to cost $10,000. It will have a capacity for 3,000 subscribers. The Wisconsin Company has let contracts for the erection of a new exchange at Fourth and Wright Streets. This building will also cost $10,000 and will have a capacity for 3,000 subscribers. The company will open a branch office at Wauwatosa.

ELECTRIC LIGHT AND POWER.

McRAE, GA.—Moore & McCrary, English-American Building, Atlanta, will let contracts for a water and light plant.

TIFTON, GA.—A ten years' exclusive franchise and contract has been granted to the Tifton Electric Light Co. for twenty 2000-cp arc lamps.

ALEXANDRIA, IND.—J. Thomas Roberts has asked the council for a franchise for an electric light, power and heating plant. He proposes to furnish street lights, not less than sixty-five lamps, for $75 per year. The term of franchise is thirty years and the city has the privilege of buying the plant any time after ten years.

MISHAWAKA, IND.—This city is the owner of an electric light plant and the rates for service have been 11 cents per kw-hour with 20 per cent. discount. It is now declared by the council that the plant is depreciating in value; that the demand for service is increasing and that the rates are so unreasonably low that no funds are available for supplementing the equipments or displacing old worn-out machinery with new. The taxpayers are complaining about being taxed to keep up a utility that ought to be self-sustaining. Discounts will be abolished and rates increased.

MILLBURY, MASS.—The Millbury, Grafton, Uxbridge and Northbridge electric lighting and power companies are to be combined and the power is to be furnished from Uxbridge.

CANTON, MO.—At the election on Sept. 23 the proposition to issue $10,000 electric light bonds was carried by a large majority.

LITTLE VALLEY, N. J.—Cattaraugus Cutlery Company, Little Valley, N. J., has installed two electric lighting plants. In the near future it will put in operation a large electric power building.

CAPE MAY, N. J.—The Cape May Light & Power Company has started the erection of its new power house, 66x150 feet, which will be equipped with 1600-hp engines direct-connected to Warren generators, furnished by the Rumsey Electric Mfg. Company, of Philadelphia. The E. Keeler Company, Williamsport, Pa., has the contract for the boilers, and the Russell Engine Company, Massillon, Ohio, for the engines.

COLUMBUS GROVE, OHIO.—The village council has completed a deal for the purchase of the local lighting plant and hereafter it will be operated by the municipal authorities.

CANAL DOVER, OHIO.—The Standard Motive Power Company, of New York, will remove its plant to Canal Dover. The company manufactures locomotives, street car motors and automobiles.

COLUMBUS, OHIO.—Director of Public Works Immel has notified the Columbus Electric Company that because of an injunction against the city restraining from awarding a contract for city lighting, the present contract which expires Oct. 1, will not be renewed. The company furnishes 620 arc lamps, and except for about 300 lamps furnished by the municipal plant, the city will likely be in darkness after Oct. 1.

SPRINGFIELD, OHIO.—The Springfield Light & Power Company has elected directors and officers as follows. Directors: W. A. Scott, Theodore Troupe, John H. Miller, and Paul Martin, Springfield; H. J. Crowley, Samuel DeCoursney and L. C. S. Tingley, of Philadelphia. President, W. A. Scott; vice-president, Theodore Troupe; secretary-treasurer, L. C. S. Tingley; general manager, John H. Miller. The company is owned by the American Railway Company, of Philadelphia.

CLEVELAND, OHIO.—The Interstate Foundry Company, of Cleveland, has completed its new foundry designed for heavy castings. It is equipped with one 40-ton, one 25-ton and four 5-ton electric traveling cranes. The Johnson & Jennings Company is moving into its new foundry plant. There are seven new structures. The foundry building proper is 110x300 feet; the pattern shop 37x50 feet, two stories; the power house 39x83 feet, and the office building 50x75 feet. The plant is to be driven by compressed air and electricity and equipped with electric traveling cranes.

OTTAWA, ONT.—An American company which manufactures a metal called "Adamite," a substitute for steel, desires to avail of 10,000 electrical horsepower at Ottawa. The company will eventually take 20,000 horse-power or more.

OTTAWA, ONT.—The Mexican Light & Power Company, with a capital stock of $12,000,000 has been incorporated at Halifax, N. S., to conduct an electric light, heat and power business. The incorporators are B. F. Pearson, R. E. Harris, C. E. Cahan, H. A. Lovett and G. F. Pearson.

THE ELECTRIC RAILWAY.

SANTA CRUZ, CALIF.—The Board of Supervisors has granted a franchise to W. J. Rodgers for an electric railway to extend five miles from Watsonville to Camp Goodall, where it is to connect with a line of steamers to run to San Francisco.

DOVER, DEL.—The Tonapah Traction Extension Company, of Philadelphia, has been incorporated here with a capital of $1,000,000. The incorporators are Alfred S. Ellitt, Wilmington, Del.; E. L. Brundette and A. W. Bacon, Philadelphia, Pa.

WASHINGTON, D. C.—The Washington, Berwyn & Laurel Electric Railway has been completed and the road is now in regular operation. The cars will be operated by the City and Suburban line until the new company provides its own rolling stock and power house, which will probably be a year hence.

MACON, GA.—It is announced that the merger of the three street railway lines of this city has been completed by the new company taking over the properties under the ordinance prepared by the city council. The deal involves about $1,000,000, and has been arranged by Savannah, Richmond and Macon capitalists, who have bought out Boston owners of two of the lines. T. J. Carling, president of one of the lines, will be in control of the operation of the consolidated system.

EVANSVILLE, IND.—The Evansville & Princeton Traction Company has increased its capital from $100,000 to $600,000. Rails are now being laid, and the line will be ready for service soon.

SOUTH BEND, IND.—Promoters of the Elkhart, South Bend and Chicago Electric Railway have made application for a franchise in this city and gave a guarantee bond of $5,000 that the road will be completed in a year.

INDIANAPOLIS, IND.—Of the hundred thousand people brought to the recent Indiana State Fair two-fifths were brought in over the interurban lines. Their half-hour and hourly service proved to be a strong competitor for the steam roads, and there was a perceptible falling off in the steam line traffic.

SEYMOUR, IND.—Representatives were in conference in this city recently concerning the construction of an electric railway from Columbus to French Lick. An organization was formed with W. P. Masters, of Seymour, as president and a survey ordered. Franchises have been granted for almost the entire distance.

MUNCIE, IND.—The Union Traction Company has stolen a march on the Muncie, New Castle & Alexandria Traction Company and is now grading a direct line from Muncie to Alexandria. For months there has been a fight between the traction companies for the right of way, and now both are building lines along parallel routes.

SHELBYVILLE, IND.—A controlling interest has been purchased by H. B. Smith, banker, of Hartford City, Edward Hawkins, of Indianapolis, and some Eastern capitalists, in the Indianapolis, Greenwood & Shelbyville Traction Company, which will build a line from Greenwood to Shelbyville. This company was incorporated nearly a year ago. A private right-of-way was obtained and considerable grading done when the work was discontinued because the company could not finance the project. Capitalists are now behind the project, and the line will be completed at once. The distance is nineteen miles. Fourteen miles of the Indianapolis and Greenwood line will be used. The road will become a direct competitor of the Indianapolis, Shelbyville and Southwestern road, which was opened to public service recently.

TOPEKA, KAN.—The Kansas City & Bonner Springs Railway Company, with headquarters at Kansas City, Kan., was granted a charter. It has a capital of $500,000. Stockholders are C. F. Hutchings, Samuel Maher and John W. Breidenthal, of Kansas City, Kan., H. H. Anderson, of Kansas City, Mo., and Edwin Taylor, of Edwardsville. This makes the third company that has taken out a charter to build a line from Kansas City to Bonner Springs. The first one was taken out in 1897, the second in 1899 and the third this year. Beside these three other concerns have been chartered at different times to build a line from Kansas City up the Kaw Valley to Lawrence and Topeka.

LOUISVILLE, KY.—At the recent meeting of the directors of the Louisville Street Railway Company a semi-annual dividend of 2½ per cent. on preferred stock was declared and a quarterly dividend of 1¼ per cent. on the common. No action was taken on the proposed increase of common stock.

GRAND HAVEN, MICH.—The work of building the Grand Rapids, Grand Haven & Muskegon Electric Railway into Grand Haven from Spring Lake, has begun. The transfer of the local street car line to the interurban company was formally made, $18,000 being paid for it.

MEDINA, N. Y.—The Union Traction Company has been incorporated to build and operate a 50-mile railway along the shore of Lake Ontario from Batavia to Olcott. The capital is $600,000. The directors are I. H. Gebille and F. L. Downes, of Medina, and J. W. Holmes, of Batavia.

DAYTON, OHIO.—The county commissioners have granted a 25-year franchise along the Dayton and Brandt turnpike to the Dayton & Kenton Traction Company.

ALLIANCE, OHIO.—The Alliance-Sebring division of the Stark Electric Railway is now in operation. The Alliance-Canton section of the road is being pushed to completion.

COLUMBUS, OHIO.—The Ohio Central Railway Company which proposes to build a line from Columbus to Lancaster has applied for a franchise in Columbus. H. C. Werner is at the head of the company.

CANTON, OHIO.—After a controversy lasting many months, the Stark Electric Railway Company has secured a franchise enabling its cars to reach the center of Canton without making a traffic arrangement with the Canton-Akron Company.

NEW PHILADELPHIA, OHIO.—The Canton-New Philadelphia Railway Company has secured a franchise through Beach City, completing the entire right of way. The section between Canal Dover and New Philadelphia will be placed in operation this fall.

KENTON, OHIO.—W. P. Hilands, of Chicago, is promoting an electric railway to extend from Kenton to Ada by way of McGuffey, Foraker, and Alger, a distance of about 18 miles. It is proposed to secure electric lighting franchises in the various towns.

CINCINNATI, OHIO.—Theodore Horstman has brought suit in the Superior Court to oust the Cincinnati Street Railway Company from the 50-year franchise it holds under the Rogers' law. A permanent injunction is also asked for, restraining the company from operating its cars over the John Street line, which is the only route involved in the original suit.

COLUMBUS, OHIO.—The Scioto Valley Traction Company has placed a contract with the Carnegie Company for 5,500 tons of rails and with the Mt. Vernon Bridge Company, Mt. Vernon, Ohio, for ten bridges. The contracts involve about $215,000. The controlling interest in this project was recently purchased from the Everett-Mocre syndicate by Columbus people.

NEW PHILADELPHIA, OHIO.—Major C. E. Mitchner, who financed and built the Uhrichsville-New Philadelphia Railway, now a part of the Tuscarawas Traction Company, has asked the county commissioners for a franchise along the highway from New Philadelphia to Newcomerstown. The proposed line will pass through Beidler, Tuscarawas, Seventeen, Port Washington and Glasgow.

CHAMBERSBURG, PA.—H. B. McNulty, secretary of the Chambersburg, Greencastle & Waynesboro Electric Street Railway Company, Chambersburg, Pa., reports that no contracts have as yet been let for the equipment of its new 2000-hp plant to be erected at Chambersburg. The company purposes to build a line from Chambersburg to Greencastle, Waynesboro and Pen Mar, a distance of 28 miles. C. H. Lattse is president.

NEW INDUSTRIAL COMPANIES.

THE AMERICAN ELECTRO-THERAPY COMPANY, Brooklyn, N. Y., has been incorporated; capital, $50,000. Directors: E. A. Calahan, J. H. Wickert and E. H. Bartley, Brooklyn.

THE ROONEY-WESTBURY ELECTRIC LAMP CO., of New York, has been incorporated with a capital of $50,000. The directors are J. J. Rooney, of Scarsdale; Harry Westbury, Harrison, N. J., and F. J. Rooney, Brooklyn.

THE STANDARD AUTOMOBILE COMPANY, of Indianapolis, Ind., has been incorporated, with a capital stock of $100,000. The directors are J. W. Hollyman, W. W. Spencer and J. H. Witty. The company has bought a plant and will begin the manufacture of automobiles on an extensive scale.

LEGAL.

LAMP LITIGATION.—We are informed that a suit has been filed by the General Electric Company against the U. S. Incandescent Lamp Company on the Malignani patent, No. 537,693 of 1895, on the chemical exhaustion of incandescent lamps. The suit is pending in the U. S. circuit court at St. Louis.

ST. LOUIS ELECTRICAL SUPPLY CO.—An application was made to the United States district court Sept. 24, to have the St. Louis Electrical Supply Company declared bankrupt. The application is made by the Fourth National Bank, the National Bank of Commerce and Rumsey & Sikemeier. The defendant company had its place of business at 1118 Pine Street.

SPLIT PHASE DECISION.—By a recent decision of the United States Circuit Court for the Southern District of New York an injunction was issued on the Tesla split phase patents, Nos. 511,559 and 511,560, in a suit against the Western Electric Company, which has been the Eastern selling agent for the Sangamo Electric Company. The injunction was directed against the new Gutmann wattmeter, made by the Sangamo Company.

WESTERN TELEPHONE CONSTRUCTION COMPANY.—The property of the Western Telephone Construction Company was sold in Chicago a few days ago, fetching $27,500, the successful bidder being Attorney Louis P. Scoville. The conversion of the assets into cash will, it is stated, enable the trustee to pay almost 50 per cent. in dividends to the creditors. The plant of the company is at Winthrop Harbor, near Waukegan, Ill.

OBITUARY.

MR. H. S. PARMELEE.—Harry S. Parmlee, a wealthy manufacturer of New Haven, Conn., was stricken with paralysis of the heart on Sept. 27 on board the sloop yacht Alert, of Brooklyn, and died in a few minutes. Mr. Parmelee, with several friends, started from New York several days ago on the yacht for a cruise to the Bermudas. He had been ill, and planned the trip, one of his friends said, for the improvement of his health. Mr. Parmelee was fifty-eight years old, and married. He was president of the Fair Haven and Westville Street Railway Company, of the Mathushek Piano Company, a director of the Treat & Shepherd Company, piano dealers, and of the Second National Bank of New Haven. Mr. Parmelee was enrolled as a member in the New Haven, the New York, the Larchmont, and the Corinthian Yacht Clubs. He invented the automatic sprinkler now extensively used in factories. He is survived by a widow, two daughters, and a son, Henry F. Parmelee, a New Haven attorney. He served through the civil war in the First Connecticut Cavalry, and lost an arm before Richmond.

PERSONAL.

MR. C. E. BROWN, E. E., is to lecture on October 7 on "Arc Lamps," before the Modern Science Club in Brooklyn.

MR. THOMAS F. RYAN, who is largely interested in electrical enterprises, returned from Europe this week. Several movements may now be expected.

MR. FRANCIS M. BUCK, second vice-president of the Twin-City Telephone Company, at St. Paul, Minn., has resigned his position. He will return to Chicago.

MR. GEORGE L. CRAGG requests us to state that his patent law offices are still as they have been for many years past, at 1450 Monadnock Building, Chicago.

MR. V. C. GILPIN has become associated with the De Veau Telephone Mfg. Company, of New York City, as sales manager and assumed his new duties on October 1.

MR. E. W. RICE, JR., vice-president of the General Electric Company, has just returned from a long European trip, and has resumed his duties at Schenectady.

MR. W. W. WHEATLEY, superintendent of the surface lines of the Brooklyn Rapid Transit system has resigned from that position. Mr. W. B. Yearance, his assistant, has also resigned.

MR. W. G. A. MILLER, formerly manager of the ornamental department of the American Bridge Company, has been appointed purchasing agent of that company, with offices at No. 259 South Fourth Street, Philadelphia, Pa.

MR. CARL SCHWARTZ, late manager of Siemens & Halske Company, at St. Petersburg, Russia, has arrived in the United States. It is the purpose of Mr. Schwartz to remain in this country and engage in professional work here.

MR. CHARLES D. JENNEY, president of the Jenney Electric Manufacturing Company, of Indianapolis, made the Chicago office of the ELECTRICAL WORLD AND ENGINEER a call last week. The company is doing a large business in apparatus.

PROF. R. S. HUTTON, of Owens College, England, who has been in this country for a short vacation, studying chiefly electro-chemical work, sailed last week for home, after a very pleasant and helpful holiday, during which he made many American friends.

MR. SAMUEL INSULL, president of the Chicago Edison Company, is interested in a company which will build a large central station at Waukegan, Ill., to supply electric light and power to suburban towns along the shores of Lake Michigan from Highland Park to Waukegan.

MR. JAS. E. HOBART, manager of the Triumph Electric & Ice Machine Company, of Cincinnati, was a visitor at the Chicago office of the ELECTRICAL WORLD AND ENGINEER recently while en route to northern Michigan on a hunting and fishing expedition with several friends.

MR. WILLIAM STANLEY, JR., who went abroad immediately after the successful meeting of the Institute in the Berkshire Hills, has just returned home to Great Barrington, Mass., where he has been fitting up the beautiful house at which a memorable fête champetre was given to the members.

PROF. W. E. GOLDSBOROUGH, of the electrical exhibits department of the St. Louis Exposition, has been doing some good work in the East during the past week, for the show, and took advantage also of the opportunity to attend the opening session of the Institute and participate in the discussion.

MR. HENRY PHIPPS, the American steel manufacturer has given $100,000 to the Boer Relief Fund on condition that it be used for bread and beef and not for politics or popguns. He returned to this country during the present week. He was once a telegraph messenger in Pittsburg with Mr. Andrew Carnegie.

MR. GEORGE W. JACKSON recently gave an illustrated lecture on the Chicago telephone tunnels at the rooms in that city of the Society of Western Engineers. A large audience listened interestedly to the details of the construction of this unique subway, which is 12 miles long. It will afford room for a service of over 100,000 telephones Mr. Jackson stated.

MR. T. D. LOCKWOOD, the well-known expert of the American Telegraph and Telephone Company, is expected home in Boston next week from England. He has been staying lately at the Russell in London. Mr. Lockwood is an Englishman by birth, but has been prominently associated with Bell interests in this country as long as they have existed—an eventful period in American electrical development.

MR. KILLINGWORTH W. HEDGES, of the Institute of Civil Engineers, a well-known writer on electrical and engineering subjects, arrived at New York last week on the Celtic. Mr. Hedges comes here as one of the Lightning Research Committee, and his purpose is to arouse interest in the work of contriving some absolute protection against lighting. Mr. Hedges hopes to establish some committees in this country.

LIEUT. COL. H. A. YORKE, of the Royal Engineers, was on board the Celtic, which arrived last week. He comes on behalf of the London Board of Trade to investigate American systems of electric railway signaling, and also to examine electric traction systems. "I shall be here about five weeks," said Col. Yorke, "and shall, after investigation, make comparisons between your systems and ours." Col. Yorke is the London Board of Trade railroad accident expert.

MR. CHARLES J. GLIDDEN, of Lowell, Mass., arrived in Paris last week, having driven a 16-hp Napier over five thousand miles. His driving days numbered thirty-eight. Mr. Glidden started on his tour from London, drove to Newhaven and then shipped his machine to Dieppe. A summary of the miles driven is as follows: England, 132; France, 2,700; Germany, 608; Austria, 250; Italy, 508; Switzerland, 897; Spain, 30; total, 5,125. Throughout the total distance Mr. Glidden experienced sixteen punctures.

MR. EDWIN R. WEEKS, of Kansas City, has formed the engineering partnership of Weeks, Kendall & Newkirk, in that city, and needs no introduction to the electrical public, although it is now a good many years since he was president of the National Electric Light Association. Mr. W. R. Kendall is a graduate of the Massachusetts Institute of Technology, and has been in active engineering practice and business life. Mr. Walter M. Newkirk is also a "Tech" man, and was an instructor in engineering there. He was on the engineering staff of the Detroit Public Lighting Commission, and a member of the firm of Smith and Conant, of New York and Detroit, engaged on patent causes, etc. The new firm will make a specialty of power generation and distribution.

ADAMS-SEEFELD.—A great many friends will note with pleasure the news of the marriage at Berlin, Germany, on September 18, of Mr Ernest Kempton Adams to Margaret, daughter of Lieut.-Col. and Mrs. Seefeld. Mr. Adams is the son of Mr. Edward D. Adams, the well-known banker who reorganized the Northern Pacific Railroad property, was a leading spirit in the Niagara power enterprise and was one of the hosts at the celebrated breakfast given Prince Henry when he met the American "Captains of Industry." The younger Mr. Adams, although of retiring disposition, has done quietly a lot of excellent work in the field of electrical invention and engineering and when at Yale was one of the editors of the "Scientific Monthly." One or two of his contributions have also appeared in the pages of this journal.

MR. GEORGE G. WARD, vice-president, general manager and director of the Commercial Cable Company, and vice-president and director of the Postal Telegraph Cable Company, arrived last week on the White Star liner Celtic. He said: "The cable between San Francisco and Manila will be completed on July 4. Three cable ships will be engaged in the work of

laying the cable. They are the Silvertown, the Colonia, and the Anglia, and one of them has left London to proceed to Manila via the Suez Canal. Another ship will follow her, and the third will go to San Francisco via the Straits of Magellan. Thus two ships will work from Manila and one from San Francisco, and they will meet somewhere in midocean and the cable will be spliced. The cable itself is now being made in London at the rate of fifty miles a day, and I expect that it will be finished in March." Mr. Ward is accompanied by Mr. Thomas Skinner, of London, who is a director of the Commercial Cable Company.

EDUCATIONAL.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The department of mechanical engineering of the Massachusetts Institute of Technology is the subject of a 32-page pamphlet just issued. A schedule of the studies, detailed descriptions of the courses and much information on the general subject are given. The pamphlet also contains many half-tone illustrations of the various laboratories, apparatus, etc., used in the practical instruction of the students. The equipment and the work of the department in its various branches are fully set forth.

Y. M. C. A.—The West Side Young Men's Christian Association, 318 West 57th Street, New York, begins its sixth season's activities in October. This Association now has a membership of over 2,300. The current expenses are $50,000 annually, less half of which are met by membership fees, a small amount by rentals and the balance by donations. There are over 600 students enrolled in the 40 evening educational classes. There are also eight literary, musical and art clubs with large memberships. The library contains 48,000 volumes, about 15,000 of which are in the circulating department. Entertainments, which are free to members and their friends, are given every week. Meetings, addressed by prominent men, are held every Sunday afternoon at four o'clock either in the Association Auditorium or in Carnegie Hall. There are classes in gymnastics every afternoon and evening. The Association has a savings fund department, an employment bureau, dormitory rooms, a restaurant, a boarding house record and many other features which are helpful to young men, especially to those whose homes are not in New York. This Association, which has the best equipment of any Y. M. C. A. in the country, is open to visitors at all times. An attractive illustrated catalogue of 64 pages, which announces the privileges offered in the various departments, may be obtained free by calling on or addressing the Secretary, 318 West 57th Street, New York.

Trade Notes.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is selling large numbers of Packard "Mogul" lamps.

THE ATWATER KENT MFG. WORKS, Philadelphia, have issued a folder printed in two colors describing "The Monoplex Telephone." This folder will be sent to anyone upon request and is accompanied by an attractive card to hang on the desk.

UNITED ELECTRIC HEATING CO.—Supplement 30, issued by the United Electric Heating Co., of Detroit, Mich., illustrates the latest additions to its lines of electric heating devices, including a new glue pot and new cooking ovens.

THE OHIO BRASS COMPANY, Mansfield, Ohio, is preparing plans for the building of an addition to its machine shop. The new building will be 56x336 feet. A new warehouse is now under course of construction, and the foundations are laid for a new insulation building.

THE OSBURN FLEXIBLE CONDUIT COMPANY, 21 Park Row, New York, reports a very brisk business at present and that its product, "Flexduct," is meeting with great success wherever used. "Flexduct" has recently been put to some very severe tests and has been highly spokn of by experts.

PORCELAIN SPECIALTIES.—A new company for the manufacture of electrical porcelain specialties is being organized at East Liverpool, Ohio, by Mr. T. F. Anderson, who has been identified with the American Sewer Pipe Company. A new factory will soon be erected for the new concern.

THE EMPIRE ELECTRICAL INSTRUMENT CO., 654 Hudson St., New York, has issued a series of bulletins on its Empire instruments. As shown by these bulletins the company produces ammeters and voltmeters of every style in use, including the illuminated dial pattern, portable type, switchboard pattern, round pattern, etc.

MR. WILLIAM ROCHE, 42 Vesey St., New York, the manufacturer and inventor of the New Standard dry battery, reports the demand for his electric gas lighters and portable flash lights as very large, the simplicity of construction and length of life being special features of these articles. The New Standard dry battery is peculiarly adaptable for all of the uses above mentioned.

THE GENERAL INCANDESCENT ARC LIGHT COMPANY, New York, in a circular invites the trade to consult it before placing orders for arc lights, asserting that money will be saved thereby. Reduced reproductions of the company's various arc-lamp bulletins are given, and the principal features of these lamps are pointed out. The circular is gotten up in attractive form and pleasing color.

THE JEWELL ELECTRICAL INSTRUMENT CO., which makes a complete line of switchboard instruments has recently removed to 61 and 63 Union Park Court, corner of Carroll Ave., Chicago, Ill. In giving notice of its change of address, the company issues instructions as to how it can be reached, and the back of its business card contains specific directions for locating its quarters.

RENOLD SILENT CHAIN.—The importance of Renold silent chain in the field of motor driving is demonstrated by the new bulletin which is devoted to that subject exclusively. Renold silent chain has been on the market in this country not quite a year. Its extended application is already notable. The bulletin No. 1001 is issued by the Link Belt Engineering Co., of Philadelphia, Pa., and consists of 12 most interesting quarto pages.

GENERAL ELECTRIC MICA WORKS.—The General Electric Company is now employing over 200 hands in its new Ottawa branch in sorting and shipping mica. Machinery will be installed at the Ottawa works for additional treatment of the mica, which can be carried on to better advantage and at cheaper rates than in Schenectady. When the Ottawa works are completed 2,000 hands will be employed and all of the output of the Canadian mines owned by the company will be treated at the Ottawa works.

THE INTERNATIONAL TELEPHONE MFG. CO., Chicago, it is reported, is having a large demand for its improved telephone switchhook. It is said that this hook is one of the most scientifically designed and durably constructed telephone switches ever produced. It has a restoring spring of more than five inches in length, made of the best spring german silver and has all the parts self-contained, with no rubbing or scraping, excepting at the platinum contact points, which form a good positive connection at all times.

COALAOC.—A preparation called "Coalaoc" is being marketed by Mr. M. A. Bobrick, 315 Walnut Street, St. Louis, Mo. It is sprinkled on coal in liquid form and is said to harden the coal, thus making it burn slower and give increased heat. Among other claims made for this substance is that, besides effecting a saving in the amount of coal consumed and giving additional heat, it insures the consumption of smoke. Mr. Bobrick claims that this preparation will effect a saving in coal consumption of 15 to 25 per cent. at a cost of 10 cents per ton.

LAVITE is an anti-corrosive, unchangeable insulating material, resisting heat to a great degree. It is made in practically any required shape, can be made for washers and bushings and takes an accurate thread. This is the new name that the D. M. Steward Mfg. Co., of Chattanooga, Tenn., has given to its well known lava insulation. The name is a coined word original with the Steward Co., with the merit of being easily remembered and almost entirely descriptive of the material of which the insulation is made. The use of this insulation is increasing and with it is a corresponding gain in familiarity with the new word.

SMITH & HEMENWAY COMPANY.—We have just received from the Smith & Hemenway Company, of 296 Broadway, New York City, a copy of the fourth edition of the Green Book of Hardware Specialties. This book is considerably larger than the last one. It contains 144 pages of highly interesting matter and is illustrated throughout by a number of half-tones. This book contains illustrations of all articles manufactured by the Smith & Hemenway and Utica Drop Forge & Tool Co.'s. It is printed on green paper and each page has a very attractive border in orange around it. This book will be quite an addition to the catalogue file of any up-to-date dealer.

VALLEE BROS. ELECTRICAL CO., Philadelphia, has recently issued, in addition to its general catalogue, twelve smaller catalogues, each of which covers thoroughly and in a convenient form for ready reference a certain department of electrical supplies. The list is as follows: Electric light supplies, electrical house goods, telephone apparatus, tools for electrical purposes, switchboards and panel boards, electrical fixtures, transformers, electrical fans, dynamos and motors, electrical instruments, arc lamps, and line material. They are all attractively gotten up and are profusely illustrated. The practical value of this idea can readily be appreciated. Any of these catalogues will be promptly mailed upon request.

THE HAINES & NOYES CO., manufacturer of telephone apparatus, Chicago, Ill., announces that it has recently opened an Eastern office, under the management of Mr. J. A. Mears and Mr. F. H. Schlesinger, at 220 Broadway, New York. This office will take care of the entire Eastern business and all prices in this territory will be f. o. b. New York. A full line of stock and samples will be carried, and inasmuch as both Mr. Schlesinger and Mr. Mears are practical electrical men as well as telephone men, the Haines & Noyes Co. states that it feels sure that all prospective purchasers as well as former customers, will be well taken care of. Mr. Schlesinger was formerly associated with Stanley & Patterson, as well as with the Peru Elec. Mfg. Co. Mr. Mears is a well-known business man of New York City. The Haines & Noyes Co. requests that all correspondence coming from the East be directed to the New York office.

ELECTRICAL SUPPLIES.—Mr. C. J. Harrington, 15 Cortlandt St., New York, has had a large personal experience in the electrical supply business and fully understands the requirements of every branch of the trade, especially in the street railway and telephone fields. He has purchased the Medbury insulating plant, which has been dismantled and moved to Mr. Harrington's Newark factory, and we are informed that the same high-grade of insulated material will be manufactured under his trade mark "Empire," instead of the Medbury name. In addition to this the Harrington firm is the sole Eastern representative of several concerns well known in the railway and electrical trade, among which are the Banner Electric Company, Youngstown, Ohio; Heil Railjoint Welding Company, Milwaukee, Wis.; and the Scranton Fire Brick & Conduit Company, of Scranton, Pa. The firm has secured space No. 6 at the Detroit Convention this month, also Parlor E at the Hotel Cadillac, where it will entertain its friends.

IDENTIFICATION WANTED!—Two postal cards were received at our office Monday of this week. One of them bore the legend:

"N. Y., Sep. 27/02.

"Gentlemen:

"We would like to change our advertisement for next week. Please call for cuts. Respectfully yours."

The other read:

"Electrical World and Engineer, 9/26/02.
114 Liberty St., N. Y.

"Gentlemen:

"Please return the zinc etching used in our "Ad" of Aug. 30, Sept. 6 and 13, and oblige, Yours very truly, ————"

Neither of them was signed, neither bore the name of any firm or any address; one of them did not even state what city it hailed from. Will the writers kindly identify them and thus enable our business department to carry out their instructions, and in the meantime please don't blame the advertising man.

NATIONAL-ACME MFG. CO., Cleveland, Ohio, has opened an Eastern office at 570 Arch Street, Philadelphia, L. M. Waite, manager. To him should be addressed all inquiries from Eastern purchasers as to the Acme automatic multiple spindle screw machine, Acme screw slotter, cap screws, set screws and other specialties.

STANDARD VITRIFIED CONDUIT.—Mr. B. S. Barnard, vice-president and secretary of the Standard Vitrified Conduit Company, before leaving his New York home office for attendance at the Street Railway Convention, reported that he has just returned from an extended trip in the South and West and that the prospects of underground conduit construction is beyond all calculation of the trade in the past. The consumption will be far greater than the production this season. This corporation is perfectly independent and is manufacturing every line of conduit known to the trade, embracing multiple and single duct forms and making a greater variety of multiple than heretofore known. The conduits on exhibition at the Street Railway Convention will show the high proficiency attained in the art of clay working, especially in such features as the glazing of the conduit and the superior vitrification. The company's factory is in New York Harbor and about January 1 will, it is said, be the largest in the world. Its enormous capacity, the superior product, and the reputation of Mr. R. W. Lyle, president, and Mr. Barnard will undoubtedly insure success of this corporation. It may be well to mention a few of the contracts awarded to this company, such as those from the Niagara Falls Power Co., United Railways of Baltimore, the Municipal Subway of Newcastle, Pa., Richmond Telephone Co., Mobile Light & Railway Co., Electric Lighting Co., of Mobile, Ala., and Vincennes, Ind., Clarksville, Tenn., Shreveport, La., Catskill, N. Y., and also the Bell Telephone Co. for many of its installations throughout the country

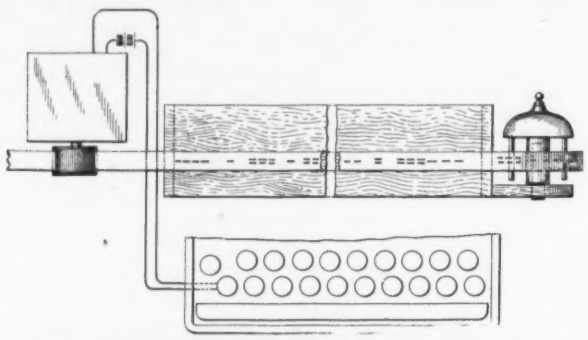
Record of Electrical Patents.

UNITED STATES PATENTS ISSUED SEPTEMBER 23, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

709,465. MEANS FOR CONTROLLING THE CHARGING OF SECONDARY BATTERIES; J. Burry, Fort Lee, N. J. App. filed Jan. 10, 1900. By means of commutators a storage battery is first connected with a charging source and then with a second battery, which it charges, and so on repeating the cycles, the second battery being continuously connected with a work circuit.

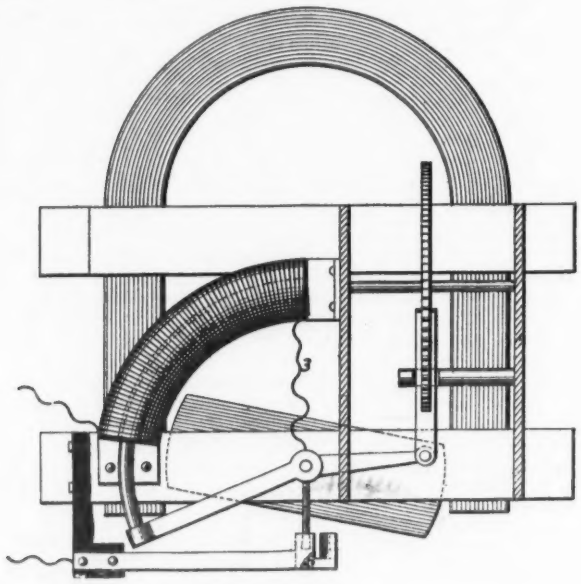
709,484. MAGNETIC WHEEL; J. O. Heinze, Jr., Revere, Mass. App.



709,752.—Means for Handling Telegraphic Receiving Tapes for Translation.

filed Feb. 24, 1902. Relates to a traction wheel containing magnets whereby friction is electromagnetically created between the wheel and rail.

709,485. INDUCTION COIL; J. O. Heinze, Jr., Revere, Mass. App. filed July 11, 1902. The induction coil is divided up so that a number of small cores can be used instead of one large one and thereby reduce the diameter of the turns on the core.



709,818.—Electric Clock.

709,504. CONDUIT; W. L. McGowan, Phila., Pa. App. filed Feb. 8, 1902. A terra cotta sectional conduit in which the ends of the sections are concave and convex on irregular curves so that they will fit together tightly where the conduit bends.

709,513. PROCESS OF FRAMING GLASS OR OTHER MATERIALS; H. W. Scattergood, Phila., Pa. App. filed June 19, 1902. (See Current News and Notes.)

709,607. ELECTRICAL RELEASER FOR FIRE DOORS, ETC.; H. J. Podlesak, Lincoln, Neb. App. filed March 16, 1897. An electro-magnetic releaser controlled by a thermostat or push button for allowing fire shutters to close in case of fire.

709,611. SECONDARY BATTERY; W. L. Silvey, Dayton, Ohio. App. filed Feb. 8, 1902. A construction affording ease of assembling and dissembling of large batteries.

709,676. ELECTRICALLY OPERATED RAILWAY SWITCH; J. Loney, Detroit, Mich. App. filed June 21, 1902. The switch point is raised and lowered vertically by a cam surface on the rod connecting the cores of two solenoids.

709,681. SAFETY DEVICE FOR MOTOR VEHICLES; A. L. Riker, New York, N. Y. App. filed March 2, 1900. A clutch between the motor and drive shaft is automatically opened when the weight of the driver is removed from the seat.

709,714. METHOD OF CONTROLLING THE ENERGY DELIVERED TO ELECTRICAL TRANSLATING DEVICES; H. W. Leonard, East Orange, N. J. App. filed Jan. 31, 1896 A method consisting in connecting the terminals of the translating device between two conductors which are electrically connected with a source of electromotive force, and varying by magnetic induction the relative potential of the two conductors independent of and without altering the connections with the source so that the potential of one of them is made to become higher or lower than that of the other, whereby the current through the translating device is reversed.

709,746. TRAIN SIGNALING APPARATUS; W. D. Clopton, Lewisburg, W. Va. App. filed Jan. 23, 1902. An electrical coupling making a through circuit between cars when connected, but each half adapted to close its own circuit when the coupling is disconnected.

709,752. MEANS FOR HANDLING TELEGRAPHIC RECEIVING TAPES FOR TRANSLATION; P. B. Delany, South Orange, N. J. App. filed Dec. 15, 1896. This invention consists of a device for pulling the tape with the received message recorded thereon across the translators' desk in definite lengths at a time, quickly and for convenience of translation about two feet at each movement.

709,762. COUPLING FOR CONDUIT RODS; J. F. Greaves, St. Louis, Mo. App. filed April 7, 1902. Details.

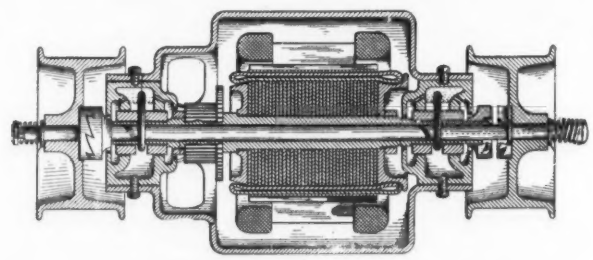
709,798. RAILWAY SIGNALING APPARATUS; E. Rowe, Indiana, Pa. App. filed June 1, 1901. Apparatus whereby the signal and other operators along the roadway can communicate by telephone with engineers on trains at any part of the road.

709,806. ELECTRICAL INDICATORS; H. S. Tittle, Los Angeles, Calif. App. filed Nov. 29, 1901. An electrically operated cash register in which the movable index can be stopped at any predetermined time or place.

709,808. CARBORUNDUM ARTICLES AND PROCESS OF MAKING SAME; F. J. Tone, Niagara Falls, N. Y. App. filed Jan. 2, 1901. (See Current News and Notes.)

709,817. ELECTROLYTICALLY TREATING ORES; C. E. Dolbear, Boston, Mass. App. filed June 3, 1901. (See Current News and Notes.)

709,818. ELECTRIC CLOCK; Newton Harrison, New York, N. Y. App. filed



709,848.—Combined Dynamo and Driving Gear.

May 11, 1901. A permanent magnet is used to propel the train of gears for a certain period of time and then an electro-magnet restores the initial relation between the permanent magnet and the train.

709,847. MEANS FOR DRIVING GENERATORS BY POWER TAKEN FROM CAR AXLES; J. L. Creveling, New York, N. Y. App. filed Sept. 11, 1901. An arrangement of clutches and belts between the axle and the armature shaft whereby the armature will be rotated always in the same direction regardless of changes of direction of rotation of the axle.

709,848. COMBINED DYNAMO AND DRIVING GEAR; J. L. Creveling, New York, N. Y. App. filed Nov. 18. 1901. A modification of the preceding patent.